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ABSTRACT

This student guide, one of a series of correspondence training courses designed to improve the job performance of members of the Marine Corps, deals with the skills needed by engineer equipment chiefs. Addressed in the five individual units of the course are the following topics: construction management (planning, scheduling, and supervision); estimation of equipment efficiency (equipment utilization, efficiency factors, crawler-tractor applications, tractor/scraper applications, road graders, and crane-shovels); construction sites; maintenance systems (maintenance support, maintenance shops, shop layout); and support functions (engineer and supply support). Each unit contains a general objective, a series of work units each addressing a different subobjective, study questions, and answers to the study questions. (MN)

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13.28d

1. ORIGIN

MCI course 13.28, Engineer Equipment Chief, has been prepared by the Marine Corps Institute.

2. APPLICABILITY

This course is for instructional purposes only.

Jmd Holladay

J. M. D. HOLLADAY
Lieutenant Colonel, U. S. Marine Corps
Deputy Director

PREFACE

ENGINEER EQUIPMENT CHIEF has been designed to provide present and future chiefs, SSgt through MGySgt in MOS's 1316, 1341, 1345, 1349, and 1391 with a source of study material on the management and operation of maintenance facilities and equipment construction projects.

SOURCE MATERIALS

NAVDTRA 10641-F	Equipment Operator 1 & C, Department of the Navy, Bureau of Naval Personnel, 1971
FM 5-20	Camouflage, May 68
FM 5-36	Route Reconnaissance and Classification, Jan 1970
FMFM 4-4	Marine Engineer Operations, 3 November 1972
TM 5-200	Camouflage Materials, 19 Apr 68
TM 5-232	Elements of Surveying, 1964
TM 5-331A	Utilization of Engineer Construction Equipment Volumn A-Earthmoving, Compaction, Grading, and Ditching Equipment, Aug 67
TM 5-331B	Utilization of Engineer Construction Equipment Volumn B-Lifting, Loading, and Hauling Equipment, May 68, w/Ch 1
TM 5-331C	Utilization of Engineer Construction Equipment Volumn C-Rock Curshers, Air Compressors, and Pneumatic Tools, Nov 68, w/Ch 1
TM 5-331D	Utilization of Engineer Construction Equipment Volumn D-Asphalt and Concrete Equipment, Apr 69
TM 5-333	Construction Management, Feb 72
TM 4700-15/ID	Tactical Equipment Record Procedures, Oct 79
JAG	Judge Advocate Manual, July 78
675P5	Euclid Operator Handbook, June 67
MCO 4790.2	Field Procedure Manual, Jan 79

ENGINEER EQUIPMENT CHIEF

Course Introduction

ENGINEER EQUIPMENT CHIEF is designed to orient engineer equipment chiefs and prospective engineer equipment chiefs in the concept of the operation and effective employment of a wide variety of engineer construction equipment and related subjects.

ADMINISTRATIVE INFORMATION

ORDER OF STUDIES

Study Unit Number	Study Hours	Subject Matter
1	4	Construction Management
2	4	Estimating Equipment Efficiency
3	2	The Construction Site
4	2	The Maintenance System
5	2	Support Functions
	2	REVIEW LESSON
	2	FINAL EXAMINATION
	18	

RESERVE RETIREMENT CREDITS:	6
EXAMINATION:	Supervised final examination without text or notes; time limit. 2 hours.
MATERIALS:	MCI 13.28d Engineer Equipment Chief Review lesson and answer sheet.
RETURN OF MATERIALS:	Students who successfully complete this course are permitted to keep the course materials. Students disenrolled for inactivity or at the request of their commanding officers will return all course materials.

HOW TO TAKE THIS COURSE

This course contains 5 study units. Each study unit begins with a general objective which is a statement of what you should learn from that study unit. The study units are divided into numbered work units, each presenting one or more specific objectives. Read the objective(s) and then the work unit text. At the end of the work unit text are study questions which you should be able to answer without referring to the text of the work unit. After answering the questions, check your answers against the correct ones listed at the end of the study unit. If you miss any of the questions, you should restudy the text of the work unit until you understand the correct response. When you have mastered one study unit, move on to the next. After you have completed all study units, complete the review lesson and take it to your training officer or NCO for mailing to MCI. MCI will mail the final examination to your training officer or NCO when you pass the review lesson.

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MARINE CORPS INSTITUTE

STUDY GUIDE

Welcome to the Marine Corps Institute correspondence training program. By enrolling in this course, you have shown a desire to improve the skills you need for effective job performance, and MCI has provided materials to help you achieve your goal. Now all you need is to develop your own method for using these materials to best advantage.

The following guidelines present a four-part approach to completing your MCI course successfully:

1. Make a "reconnaissance" of your materials;
2. Plan your study time and choose a good study environment;
3. Study thoroughly and systematically;
4. Prepare for the final exam.

I. MAKE A "RECONNAISSANCE" OF YOUR MATERIALS

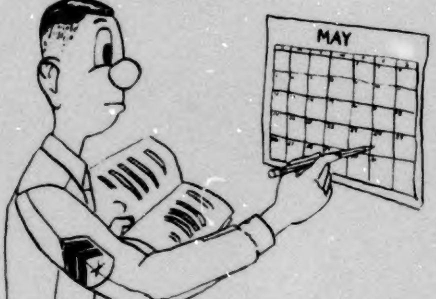
Begin with a look at the course introduction page. Read the COURSE INTRODUCTION to get the "big picture" of the course. Then read the MATERIALS section near the bottom of the page to find out which text(s) and study aids you should have received with the course. If any of the listed materials are missing, see Information for MCI Students to find out how to get them. If you have everything that is listed, you are ready to "reconnoiter" your MCI course.

Read through the table(s) of contents of your text(s). Note the various subjects covered in the course and the order in which they are taught. Leaf through the text(s) and look at the illustrations. Read a few work unit questions to get an idea of the types that are asked. If MCI provides other study aids, such as a slide rule or a plotting board, familiarize yourself with them. Now, get down to specifics!

II. PLAN YOUR STUDY TIME AND CHOOSE A GOOD STUDY ENVIRONMENT

From looking over the course materials, you should have some idea of how much study you will need to complete this course. But "some idea" is not enough. You need to work up a personal study plan; the following steps should give you some help.

Ⓐ Get a calendar and mark those days of the week when you have time free for study. Two study periods per week, each lasting 1 to 3 hours, are suggested for completing the minimum two study units required each month by MCI. Of course, work and other schedules are not the same for everyone. The important thing is that you schedule a regular time for study on the same days of each week.



Ⓑ Read the course introduction page again. The section marked ORDER OF STUDIES tells you the number of study units in the course and the approximate number of study hours you will need to complete each study unit. Plug these study hours into your schedule. For example, if you set aside two 2-hour study periods each week and the ORDER OF STUDIES estimates 2 study hours for your first study unit, you could easily schedule and complete the first study unit in one study period. On your calendar you would mark "Study Unit 1" on the appropriate day. Suppose that the second study unit of your course requires 3 study hours. In that case, you would divide the study unit in half and work on each half during a separate study period. You would mark your calendar accordingly. Indicate on your calendar exactly when you plan to work on each study unit for the entire course. Do not forget to schedule one or two study periods to prepare for the final exam.

Ⓒ Stick to your schedule.

Besides planning your study time, you should also choose a study environment that is right for you. Most people need a quiet place for study, like a library or a reading lounge; other people study better where there is background music; still others prefer to study out-of-doors. You must choose your study environment carefully so that it fits your individual needs.

III. STUDY THOROUGHLY AND SYSTEMATICALLY

Armed with a workable schedule and situated in a good study environment you are now ready to attack your course study unit by study unit. To begin, turn to the first page of study unit 1. On this page you will find the study unit objective, a statement of what you should be able to do after completing the study unit.

DO NOT begin by reading the work unit questions and flipping through the text for answers. If you do so, you will prepare to fail, not pass, the final exam. Instead, proceed as follows:

Ⓐ Read the objective for the first work unit and then read the work unit text carefully. Make notes on the ideas you feel are important.

Ⓑ Without referring to the text, answer the questions at the end of the work unit.

Ⓒ Check your answers against the correct ones listed at the end of the study unit.

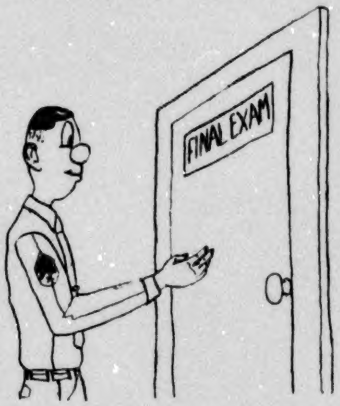
Ⓓ If you miss any of the questions, restudy the work unit until you understand the correct response.

Ⓔ Go on to the next work unit and repeat steps Ⓐ through Ⓓ until you have completed all the work units in the study unit.

Follow the same procedure for each study unit of the course. If you have problems with the text or work unit questions that you cannot solve on your own, ask your section OIC or NCOIC for help. If he cannot aid you, request assistance from MCI on the Student Course Content Assistance Request included with this course.

When you have finished all the study units, complete the course review lesson. Try to answer each question without the aid of reference materials. However, if you do not know an answer, look it up. When you have finished the lesson, take it to your training officer or NCO for mailing to MCI. MCI will grade it and send you a feedback sheet listing course references for any questions that you miss.

IV. PREPARE FOR THE FINAL EXAM



How do you prepare for the final exam? Follow these four steps:

Ⓐ Review each study unit objective as a summary of what was taught in the course.

Ⓑ Reread all portions of the text that you found particularly difficult.

Ⓒ Review all the work unit questions, paying special attention to those you missed the first time around.

Ⓓ Study the course review lesson, paying particular attention to the questions you missed.

If you follow these simple steps, you should do well on the final. GOOD LUCK!

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STUDY UNIT 1

CONSTRUCTION MANAGEMENT

STUDY UNIT OBJECTIVE: UPON SUCCESSFUL COMPLETION OF THIS STUDY UNIT, YOU WILL BE ABLE TO LIST THE PROCEDURES FOR PLANNING AN ENGINEER OPERATION AND EMPLOYING PERSONNEL AND ENGINEER EQUIPMENT. YOU WILL BE ABLE TO DESCRIBE THE PROPER USE OF JOB SUPERVISION AND EQUIPMENT SUPERVISION. YOU WILL BE ABLE TO DESCRIBE THE PURPOSE, FREQUENCY, AND TYPES OF INSPECTIONS USED IN AN ENGINEER ORGANIZATION.

Effective job management is essential for prompt and efficient completion of any construction project. Ineffective management can result in time-consuming delays. However, unexpected problems do arise: lack of personnel and materials, unforeseen obstacles caused by the nature of the terrain, and equipment breakdowns. Faced with situations such as these, the equipment chief must make a quick evaluation of the situation and decide upon a practical course of action to complete the assigned task in the allotted time. This is the goal of successful management: completion of the construction project within the specified time limits through the effective use of manpower, materials, and equipment.

The process of management is a logical sequence of events which continues throughout the entire construction project. It starts with preliminary reconnaissance, sketches, surveys, and estimates. It ends with a completed record at the conclusion of the project. The three phases that make up successful management of a construction project are planning, scheduling, and close supervision of the work to assure adherence to schedules and plans. The first two phases are closely related, while the third is somewhat distinct. The first step in executing any construction project is to make an accurate field survey including the collection of maps, photographs, profiles, and cross sections. From the survey the amount of material to be moved or excavated can be determined. The length of hauls and the amount of brush and trees to be cleared can also be determined. These and other pieces of information serve as the basis for scheduling. Scheduling is the development of a detailed plan for the performance of work to achieve maximum effort from personnel and equipment with a maximum economy of materials. Completion dates and assignment of equipment, personnel, and materials to specific jobs are part of the overall job plan. This plan coordinates all construction operations and indicates how available equipment and personnel will be used. The supervision phase includes control, coordination, and adjustment of the construction schedules. Good supervision requires personal inspection of the project to insure achievement of the intent of the plans and directives.

Section I. PLANNING

Work Unit 1-1. PLANNING AN ENGINEER CONSTRUCTION PROJECT

STATE DURING WHICH PHASE OF AN AMPHIBIOUS OPERATION YOU SHOULD PLAN FOR THE AMOUNTS OF CONSTRUCTION MATERIALS, EQUIPMENT, AND TROOPS NEEDED FOR AN ENGINEER TASK.

To insure that assigned engineer tasks can be accomplished after arrival in the objective area, a considerable amount of detailed planning is needed. This planning should be accomplished during the planning phase of the amphibious operation. During this phase you should plan for the anticipated requirements for the amounts of construction materials, equipment, and troops. During the initial planning of the assigned engineer task to be accomplished, it is essential that certain facts and information be available. It may become essential to collect additional information by reconnaissance. Adequate intelligence will seldom, if ever, be available to provide the engineer with all the information required. Any lack of information must be overcome by planning that is based on sound judgement and prior experience. The amount of detailed planning required in the task plan will be directly related to the complexity of the work to be performed. A detailed plan required to accomplish a major engineer task may include:

A brief summary of the plan including the utilization of resources available.

A site plan showing where the work is to be performed.

Design calculations.

Work programs.

Drawings and sketches.

Various schedules for materials, equipment, phasing, and completion.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. State during which phase of the amphibious operation you should plan for the amounts of construction materials, equipment, and troops needed for an engineer task.

   ____

2. How should you determine the amount of detailed planning needed in the task plan?

   ____

Work Unit 1-2. PROJECT SITE CONDITIONS

LIST WHICH TYPES OF WEATHER ARE BEST SUITED FOR CONSTRUCTION AND EARTHMOVING OPERATIONS.

STATE WHICH SITE CHARACTERISTICS INFLUENCE THE TYPE OF EQUIPMENT AND CONSTRUCTION PROCEDURES TO BE USED AT A CONSTRUCTION SITE.

Conditions of the construction site directly influence the layout of the construction project, the selection of the types of equipment that will be used, and the planning and scheduling of construction operations.

Weather. Long-range planning of construction activities includes consideration of normal seasonal changes in local weather. Warm weather is ideal for construction work. Light rains are also beneficial. Continued rainfalls like those encountered in the tropics hinder most phases of construction and earthmoving operations. Cold weather requires special equipment for handling soils and aggregates, and extra maintenance for equipment. In addition, cold weather lowers personnel efficiency, which affects the production rate.

Topography and soil conditions. The topographic characteristics of the construction site control the volume of cut and fill, the length of hauls, and the location and layout of material plants or burrow pits. Topography influences the types of equipment and construction procedures to be used and the location of maintenance areas. The types of materials excavated, sources of embankment materials, and the types of equipment to be employed are determined by soil conditions. The types and structure of rock formations affect cut and fill operations, especially if drilling and blasting are required. Rock work is costly and time consuming and should be avoided if possible. The type and structure of rock formations will determine their suitability for use as fill, base course, and surface course preparation. When bedrock is close to the surface, its type and structure should be noted. This will have a distinct effect on drainage and suitability for use as a natural foundation.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. List which types of weather are best suited for construction and earthmoving operations?

   a. ____
   b. ____

2. What effect does cold weather have on personnel efficiency?

   ____

3. State which characteristics influence the type of equipment and construction procedures to be used at a construction site.

   ____

4. The type and structure of rock formations determines their suitability for use as fill.

   a. True   b. False

Work Unit 1-3. LOCAL RESOURCES AVAILABLE

LIST WHICH LOCAL RESOURCES CAN BE USED AT A CONSTRUCTION SITE.

In military construction, every effort should be made to use available local resources. These include local labor as well as local construction materials and equipment. An inventory of available labor, equipment, and materials should be made. The final list should include only those resources that are immediately available. This list will make it possible to determine what additional support will be required to sustain the construction project.

Labor. Local labor is often used to supplement troops and equipment and to release administrative personnel for training as technicians or operators. The use of local labor increases the risk of sabotage and espionage, and requires rigid security precautions. Local laborers are usually employed most efficiently when supervised by local foremen and when allowed to use tools with which they are familiar. Laborers are usually paid at the fair local rate for the type work they perform.

Materials. The quantities of materials on hand must be compared with the quantities of materials that will be needed. This will allow for arrangements to be made for obtaining those materials which are needed. Local facilities, such as buildings, roads, quarries, and water sources, are used whenever possible. The volume and tonnage of construction materials is frequently so large that every effort should be made to use available local materials and resources.

Equipment. Local construction, transportation, and farm equipment can be adapted for use on construction projects. Captured enemy equipment should be repaired and used if possible.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. What type of supervision is the most desirable one when employing local labor?

____

2. List which local resources can be used at a construction site.

a. ____
b. ____
c. ____

3. Which local facilities can be used at a construction site?

____

4. What should be done with captured enemy construction equipment?

____

Work Unit 1-4. PROJECT TASK ASSIGNMENT

NAME THE MOST DESIRABLE FORM OF WORK ASSIGNMENT.

Engineer plans, prior to an amphibious operation, are normally prepared at brigade and higher levels. This information is distributed to subordinate units in the form of a standard five-paragraph order. This order contains such information as situation, mission, details of specific tasks to subordinate engineer units, administration and logistics instructions, and command and communications instructions necessary to insure proper execution of engineer missions. After appropriate staff planning by the division engineer and approval by the landing-force commander, the subordinate elements are assigned specific tasks. This is the unit task assignment and is the most desirable form of work assignment. The unit task assignment clearly defines the job to be done. It may include preliminary and/or fragmentary plans and specifications, or it may refer simply to standardized drawings and specifications. The task assignment will normally include the following information:

Description of the mission.

Location of the proposed construction.

Starting and completion dates.

Supply information as to construction materials, etc.

Priority of the mission.

Unit size to complete the task and additional support if required.

As an equipment chief, you will not have much of an opportunity to come in contact with the prior planning phase of selected construction projects, but will receive your assignment from the company commander. The company commander receives his assignment from the battalion commander, who is assisted by the battalion operations officer (S-3).

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. Prior to an amphibious landing, at which level are engineer plans normally prepared? ______________________________

2. Name the most desirable form of work assignment.

____

Work Unit 1-5. SITE RECONNAISSANCE

LIST FOUR TYPES OF INFORMATION CONTAINED IN ENGINEER RECONNAISSANCE.

Reconnaissance is used to keep the engineers completely aware of matters of present or potential concern from the engineer viewpoint. It is used to obtain technical information not otherwise available, to verify information obtained from other sources, and to determine the availability of local resources. Engineer reconnaissance is preplanned, organized, and continuous. The engineers making the reconnaissance should make certain they know the exact information desired. All engineer NCO's must be capable of conducting an engineer reconnaissance. Future engineer planning and operations depend on the information obtained; therefore, all reconnaissance should be thorough and accurate. Standard forms such as the one shown in figures 1-1 and 1-2 cover the usual types of engineer reconnaissance. These are usually issued, in advance, to engineer personnel. Some of the more common types of engineer reconnaissance are:

Routes of communication.

Bridges and bridge sites.

Water sources.

Construction materials and equipment.

Roads and road sites.

Airfields and airfield sites.

All information provided in a reconnaissance should be stated as fact. Sketches, drawings, and photographs are good methods of recording information and should be used whenever possible. During the reconnaissance of a projected construction site, the reconnaissance party should make overlays to show possible routes to the job site, natural material sources, potential defensive positions, and potential storage areas.

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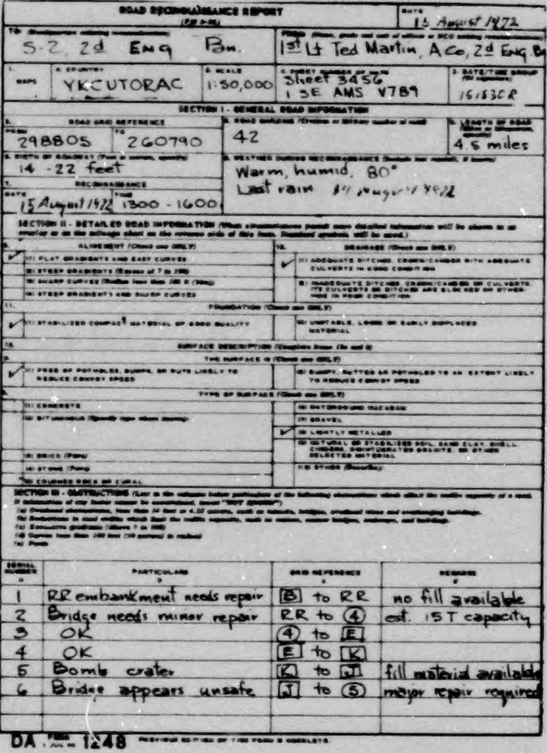

ROAD RECONNAISSANCE REPORT

DATE: 15 August 1972

TO: S-2, 2d Eng Bn.

FROM: 1st Lt Ted Martin, A Co, 2d Eng B

1. MAPS
a. COUNTRY: YKCUTORAC
b. SCALE: 1:50,000
c. SHEET NUMBER: Sheet 3456 1 SE AMS V789
2. DATE/TIME GROUP: 151530R

SECTION I - GENERAL ROAD INFORMATION

3. ROAD GRID REFERENCE
FROM: 298805
TO: 260790
4. ROAD MARKING: 42
5. LENGTH OF ROAD: 4.5 miles
6. WIDTH OF ROADWAY: 14 - 22 feet
7. RECONNAISSANCE
DATE: 15 August 1972
TIME: 1300 - 1600
8. WEATHER DURING RECONNAISSANCE: Warm, humid, 80° Last rain 14 August 1972

SECTION II - DETAILED ROAD INFORMATION [illegible]

9. ALIGNMENT (Check one ONLY)
☑ (1) FLAT GRADIENTS AND EASY CURVES
☐ (2) STEEP GRADIENTS
☐ (3) SHARP CURVES
☐ (4) STEEP GRADIENTS AND SHARP CURVES

10. DRAINAGE (Check one ONLY)
☑ (1) ADEQUATE DITCHES, CROWN/CAMBER WITH ADEQUATE CULVERTS IN GOOD CONDITION
☐ (2) INADEQUATE DITCHES, CROWN/CAMBER OR CULVERTS [illegible]

11. FOUNDATION (Check one ONLY)
☑ (1) STABILIZED COMPACT MATERIAL OF GOOD QUALITY
☐ (2) UNSTABLE, LOOSE OR EASILY DISPLACED MATERIAL

12. SURFACE DESCRIPTION
a. THE SURFACE IS (Check one ONLY)
☑ (1) FREE OF POTHOLES, BUMPS, OR RUTS LIKELY TO REDUCE CONVOY SPEED
☐ (2) BUMPY, RUTTED OR POTHOLED TO AN EXTENT LIKELY TO REDUCE CONVOY SPEED
b. TYPE OF SURFACE (Check one ONLY)
☐ (1) CONCRETE
☐ (2) BITUMINOUS
☐ (3) BRICK
☐ (4) STONE
☐ (5) CRUSHED ROCK OR CORAL
☐ (6) WATERBOUND MACADAM
☐ (7) GRAVEL
☑ (8) LIGHTLY METALLED
☐ (9) NATURAL OR STABILIZED SOIL, SAND CLAY, SHELL, CINDERS, DISINTEGRATED GRANITE, OR OTHER SELECTED MATERIAL
☐ (10) OTHER

SECTION III - OBSTRUCTIONS [illegible]

SERIAL NUMBER a	PARTICULARS b	GRID REFERENCE c	REMARKS d
1	RR embankment needs repair	B to RR	no fill available
2	Bridge needs minor repair	RR to ④	est. 15 T capacity
3	OK	④ to E	
4	OK	E to K	
5	Bomb crater	K to J	fill material available
6	Bridge appears unsafe	J to ⑤	major repair required

DA FORM 1248

Fig 1-1. Road reconnaissance report (front).

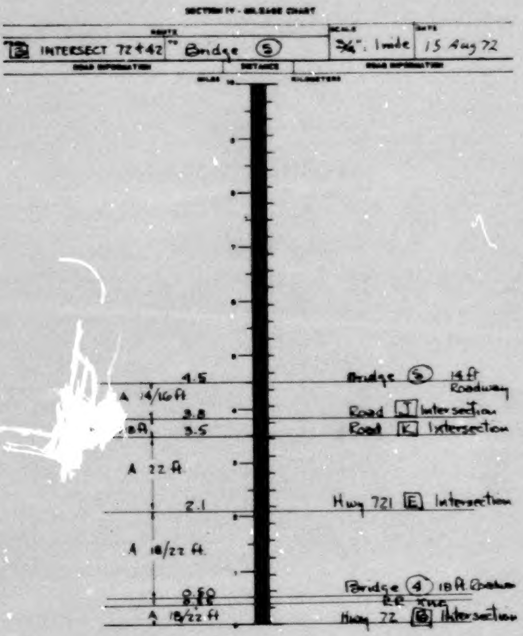
SECTION IV - MILEAGE CHART
ROUTE
SCALE
DATE
B INTERSECT 72+42
TO Bridge ⑤
¾" : 1 mile
15 Aug 72
ROAD INFORMATION
DISTANCE
MILES
KILOMETERS
4.5
A 14/16 ft
3.8
18 ft
3.5
A 22 ft
2.1
A 18/22 ft
0.50
0.48
A 18/22 ft
Bridge ⑤ 14 ft Roadway
Road J Intersection
Road K Intersection
Hwy 721 E Intersection
Bridge ④ 18 ft Roadway
RR Xing
Hwy 72 B Intersection

Fig 1-2. Road reconnaissance report (back).

Routes. The purpose of route reconnaissance is to gain information which will aid in the selection of routes to be used for the movement of equipment and materials. This information will allow construction teams to move effectively without obstructing each other. Time has a big influence on the selection of the routes between the construction site and the material resources areas. Natural obstructions such as stream beds, swamps, flooded areas, and mountains should be avoided if at all possible. When operating in a forward area, camouflaging of these routes should be taken into consideration.

Defensive positions. Planning to reduce the effects of enemy interference must be based on enemy capabilities. These capabilities vary as the enemy potential changes. Plans should provide for the developing of standard operational procedures for defense of the working crews and the protection of the construction site in the event of an enemy attack from air or ground forces. Camouflaging of construction equipment is generally impractical, since normal work dispersion is adequate. Defensive positions covering avenues of approach to the construction site should be noted, and plans to have them brought under control should be made. Evacuation routes for equipment and material should be noted. Maximum attention should be given to developing realistic and workable plans to meet probable emergency situations. In all construction, whether in forward or rear areas, existing facilities must be protected to prevent destruction or damage. Unnecessary damage to these facilities may require extra manpower, materials, and equipment to regain losses. This loss of time and materials far exceeds that which is necessary to prevent destruction.

Storage areas. Selection of materials storage areas must be one of the first items scheduled in the plan for construction. The location of the storage areas should not interfere with construction operations, but they should be close enough to operations so that materials will be readily available. Such items as rock crushers and asphalt plants must be placed in the best locations with respect to the raw materials. Movable engineer equipment must have parking areas and maintenance facilities. It may be advantageous to provide temporary shop facilities for work to be done on an assembly line basis to meet the needs of the construction site. Concrete forms and panels might be constructed in the rear area and transported to the site when needed. The storage areas should be arranged so as to permit easy movement of trucks and materials handling equipment. The size of storage areas can be roughly estimated at one square yard per ton of material.

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Natural material resources. Wooded areas with trees large enough for use as timbers in bridging and other construction should be noted. Other areas to be considered are those areas that could be used as quarries for crushed rock and gravel. Rivers and small lakes can be useful for water supply.

EXERCISE: Answer the following questions and check your answers against those listed at the end of the study unit.

1. Engineer reconnaissance ends when construction of a project begins.

   a. True　　　　b. False

2. List four types of information contained in engineer reconnaissance.

   a. ______________________________
   b. ______________________________
   c. ______________________________
   d. ______________________________

3. Natural obstructions such as swamps and flooded areas can be an advantage to a construction site.

   a. True　　　　b. False

4. Why should defensive positions be considered while making an engineer reconnaissance?

   ____
   ____

5. What is one of the first items scheduled for construction?

   a. Parking for the CO's jeep
   b. Staff NCO club
   c. Dining facility
   d. Storage areas

Section II. SCHEDULING

In scheduling, the planner arranges each sub-task in the logical sequence in which the task would occur. This is done after he has balanced the available sources of manpower and equipment required to place, move, or fabricate the available material so as to accomplish each sub-task within the time allotted. Speedy, efficient, and workable schedules can be prepared only when the planner gives consideration to both construction principles and existing limitations. One of the first principles is to start, as soon as possible, that portion of the project that will take the longest to complete. The men and equipment should be kept going on the job as long as possible. Speed and efficiency can be obtained by the use of this principle. In scheduling, one of the major limitations is that at no time may the physical capabilities of the equipment be exceeded. That is, a piece of equipment can not be used at two different places at the same time. Another limitation is that at no time can jobs be done out of sequence. An example of this is that stripping cannot be done before grubbing. The application of these limitations will provide a workable schedule. In scheduling the use of equipment and work items, some aids that can be reproduced locally are the Work Estimate Sheet, the Equipment Requirement and Assignment Schedule, and the Construction Operation Schedule.

Work Unit 1-6. EMPLOYMENT OF PERSONNEL

LIST THE THREE TYPES OF PERSONNEL THAT CAN BE USED TO ACCOMPLISH AN ENGINEER OPERATION.

The types of personnel and equipment that can be used for accomplishing essential engineer tasks are many and varied. For this reason, it is not practical to provide each subordinate engineer unit of the battalion with every skill and item of equipment available. No single engineer unit is capable of performing comprehensive engineer missions in support of independent operations.

Detached engineer units are reinforced specifically for the assigned mission. Platoons may be assigned special equipment and men from company headquarters. The companies depend upon battalion headquarters for certain services and personnel. The employment of engineer troops on tasks that do not require technical skills should generally be avoided. The capabilities and use of labor in road and airfield construction are discussed here in relationship to employment, classification, and measures of work capacity. There are three classes of labor: troop labor, local civilian labor, and prisoner-of-war labor. The ability of a unit to do work is determined by:

Work output per man per day.

Man hours per day normally available from the unit, frequently expressed in larger units of work capacity such as platoon-days or battalion months.

Additional man-hours per day available from the unit in an emergency.

There are a number of factors which determine the man-hours that can be normally worked per day. A 10-hour work day in a combat zone is desirable, but troops can work 12 hours per day when necessary. The construction strength of the unit assigned to the job will determine the total man-hours per day. The hours of daylight and the availability of night lighting equipment will determine the length of the workday. The number of shifts depends on the unit strength, the length of the day, and the availability of tools and equipment. Provisions for maintenance of equipment will modify the number of hours personnel can work. Usually two 10-hour shifts can be maintained if maintenance personnel can be used during the 4-hour shut down period and daily maintenance is done on the site. Since operators must be allowed time for before-and after-operations maintenance, about nine hours of effective work can be realized when a mid-shift meal is served on the job site.

Troop labor. The construction strength of a unit is the number of men from that unit actually available for the construction work. Administrative and housekeeping personnel not available for duty are not included in the construction strength figure. The strength of the engineer unit engaged in construction should not be less than 65% of onboard strength. The work capacity (in man-hours) of a unit is based on its construction strength. The emergency strength includes personnel that were previously exempted.

Local civilians. Construction demands in a combat zone usually exceed the capacity of available engineer troops. When possible, the excess work can be handled by utilizing local civilian labor. Hiring of local civilians boosts the local economy and trains the local populace in certain skills which are beneficial to the community and to their country as a whole. Such personnel should be carefully selected to maintain local security and work efficiency, and to prevent pilferage and sabotage. It is advisable to select a local leader, tribal or village chief, or locally recognized authority to serve as a labor superintendent. Wherever possible, whole existing labor organizations are hired. The selection of local civilian labor will be carried out in accordance with standard operating procedures established by military government or other authority. In scheduling construction, allowances must be made for absenteeism caused by illness and by misunderstandings, language difficulties, religious obligations and customs. Because civilian populations are often poorly fed or diseased, absenteeism may be as high as one day per week per man. Consequently with a six-day workweek, the reduction in actual man-days may be as high as 25%. This figure is obtained by multiplying the number of construction laborers (exclusive of administration personnel) by the number of workdays allotted to the project. These figures will vary with conditions and should be adjusted to conform with experience in a given area.

Prisoner-of-war labor. Prisoners-of-war may be used effectively to augment engineer units in the construction of roads and civilian airfields. Prisoners are subject to the laws, regulations, and orders in force in the armed services of the United States, including the Uniform Code of Military Justice. Prisoners are to be treated humanely at all times. They should be protected from violence, insults, and curiosity. Measures of reprisal are prohibited. The rules of land warfare set down by the Geneva Convention, Articles 31 and 32, restrict the employment of prisoners-of-war to those tasks that have no relation to war operations and those not involving dangerous or unhealthy work. The possibilities of extensive sabotage and the possible requirements of excessive guard and supervisory personnel may limit the use of prisoner-of-war labor on many projects. Supervision on the job is done by the using unit. Immediate supervision is done by their own NCO's, who receive instructions from the officer in charge of the construction project.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. In a combat zone, what would be the most desirable amount of hours in a work day? ____________________

2. List the three types of personnel that can be used to accomplish an engineer operation.

   a. ____________________
   b. ____________________
   c. ____________________

3. List three of the problems that may be created by the use of local civilians.

   a. ____________________
   b. ____________________
   c. ____________________

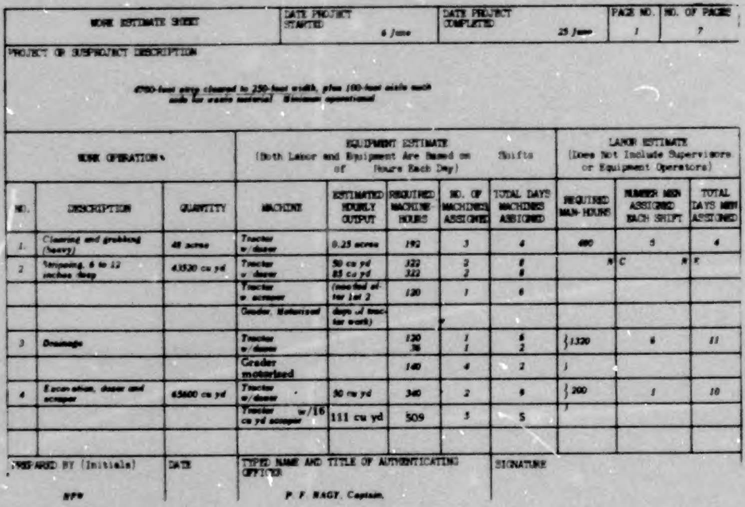
4. Prisoners-of-war may be used in the construction of vital roads and military airfields.

   a. True   b. False

Work Unit 1-7. WORK ESTIMATE SHEET

CALCULATE, BY THE USE OF FORMULAS, THE NUMBER OF MACHINE HOURS AND DAYS NEEDED TO COMPLETE AN ENGINEER PROJECT.

The project is named, numbered, or described in the project or description block of the work estimate sheet (fig 1-3); starting and completion dates are entered in their appropriate blocks. The dates are often dictated by the job or task assignment. The three columns under the "Work Operation" section constitute a summary of the quantity survey. The work operations are numbered consecutively in the first column. The second column is a description of the work to be done. Column three should include such information as the number of acres to be cleared and the cubic yards of earth to be moved. The next five columns, headed "Equipment Estimate", are completed at the same time (more information on equipment estimation is included in chapter 2). In the first of these five columns is listed the types of equipment to be used to complete the various stages of work listed under "Description". This information can be based on past experience, on similar projects under similar conditions, or it can be estimated as will be shown in study unit 2. The next column, headed "Estimated Hourly Output", gives information such as the estimated acres per hour or cubic yards per hour. The third column is the required machine hours necessary to complete that particular phase of construction listed under "Description". This figure is derived by dividing the "estimated hourly output" into "work operation quantity". A machine-hour is the use of an item of equipment for one clock hour. The last two columns under "Equipment Estimate" involve a decision of how many items of equipment should be assigned to the operation and the number of days to be allotted for the completion of that specific work item. The total days that the machines are assigned can be arrived at by multiplying the number of machines assigned times the number of hours of work in the workday. Then divide the results into the required machine-hours. The number of pieces of equipment assigned to a particular task is based on two primary considerations: the amount of equipment available and the completion dates.



WORK ESTIMATE SHEET	DATE PROJECT STARTED 6 June	DATE PROJECT COMPLETED 25 June	PAGE NO. 1	NO. OF PAGES 7

PROJECT OR SUBPROJECT DESCRIPTION

4750-foot strip cleared to 250-foot width, plus 100-foot aisle each side for waste material. Minimum operational

WORK OPERATIONS			EQUIPMENT ESTIMATE (Both Labor and Equipment Are Based on Shifts of Hours Each Day)					LABOR ESTIMATE (Does Not Include Supervisors or Equipment Operators)		
NO.	DESCRIPTION	QUANTITY	MACHINE	ESTIMATED HOURLY OUTPUT	REQUIRED MACHINE-HOURS	NO. OF MACHINES ASSIGNED	TOTAL DAYS MACHINES ASSIGNED	REQUIRED MAN-HOURS	NUMBER MEN ASSIGNED EACH SHIFT	TOTAL DAYS MEN ASSIGNED
1.	Clearing and grubbing (heavy)	48 acres	Tractor w/dozer	0.25 acres	192	3	4	480	5	4
2	Stripping, 6 to 12 inches deep	43520 cu yd	Tractor w/ dozer	50 cu yd 85 cu yd	322 322	2 2	8 8	N	C N	E
			Tractor w/ scraper	(needed after 1st 2	120	1	6			
			Grader, Motorized	days of tractor work)						
3	Drainage		Tractor w/dozer		120 36	1 1	6 2	1320	6	11
			Grader motorized		140	4	2			
4	Excavation, dozer and scraper	65600 cu yd	Tractor w/dozer	50 cu yd	340	2	8	200	1	10
			Tractor w/16 cu yd scraper	111 cu yd	509	3	5			

PREPARED BY (Initials) NPW	DATE	TYPED NAME AND TITLE OF AUTHENTICATING OFFICER P. F. NAGY, Captain	SIGNATURE

Fig 1-3. Sample Work Estimate Sheet.

Estimation of total machine-hours and total days to complete a specific task assignment are given in the following examples.

EXAMPLE 1: You are supervising a project that requires 48 acres of land to be cleared. You have estimated that your dozers have a capability of work output of 0.25 acres per hour. How many machine-hours will be required to complete this assignment?

The formula: $M=\frac{a}{b}$ Where: M=machine hours a=area to be cleared b=dozer output per hour

Solution to example 1: $M=\frac{a}{b}$

$$M=\frac{48}{0.25}$$

M=192 hours

EXAMPLE 2: You have in your work force 3 dozers, working 2 shifts of 10 hours each. Using the answer from example 1, how many days will it take to complete the task?

Formula: $D=\frac{M}{a.b.c}$

Where: D=days

M=machine-hours

a=dozers

b=hours of work

c=shifts

Solution to example 2: $D=\frac{M}{a.b.c}$

$$D=\frac{192}{3\times10\times2}$$

$$D=\frac{192}{60}$$

D=3.2 days

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The last three columns on the work estimate sheet, under the heading "Labor Estimate", are used to determine man hours, number of men assigned, and total days men assigned. "Required Man Hours" are determined by multiplying "Number Men Assigned Each Shift" by "Total Days Men Assigned".

Total days men assigned has to be converted to hours. For example, 2 shifts (10 hours each) each day for 4 days would equal 80 hours.

2(shifts) x 10(hours) = 20(hours work per day)

20 x 4 days = 80 hours

Example: You have 6 men assigned to your work task for 4 days. There will be 2 shifts each day, 10 hours each. What is the total "Required Man Hours"?

The formula: H=a x b Where: H=man hours

a=number of men

b=total days men assigned

Solution to example: H=a x b

H=6 x 80

H=480 Required Man Hours

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. The work estimate sheet is used to show the progress of a project.

   a. True b. False

2. Calculate by the use of the formulas given, the number of machine hours and days needed to complete the engineer project, in the following problems.

   a. You are supervising a project that requires 36 acres of land to be cleared. You have estimated that your dozers have a capability of work output of 0.25 acre per hour. How many machine-hours will be required to complete this assignment?

   ____

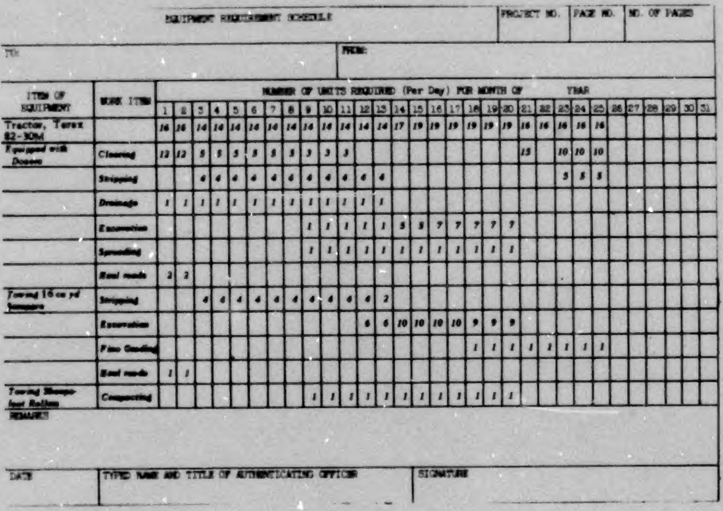
   b. You have in your work force 4 dozers working 2 shifts of 8 hours each. Using the answer from the previous example, how many days will it take to complete the task?

   ____

Work Unit 1-8. EQUIPMENT REQUIREMENT SCHEDULE

STATE THE PURPOSE OF AN EQUIPMENT REQUIREMENT SCHEDULE.

As the work estimate sheet and the construction operations schedule are developed, equipment schedules are prepared showing the daily requirements. Equipment schedules may be adjusted as necessary. When one work item is ahead of schedule, equipment should be shifted to a work item that is lagging. The first column of the form (fig 1-4) lists the type of equipment to be used. The second column lists the type of work for which each piece of equipment is to be assigned. The balance of the chart is headed by calendar days under which is listed the amount of each type of equipment that is required daily for each work item.



EQUIPMENT REQUIREMENT SCHEDULE | PROJECT NO. | PAGE NO. | NO. OF PAGES

TO: | FROM:

ITEM OF EQUIPMENT	WORK ITEM	NUMBER OF UNITS REQUIRED (Per Day) FOR MONTH OF YEAR																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Tractor, Terex 82-30M		16	16	14	14	14	14	14	14	14	14	14	14	14	17	19	19	19	19	19	19	16	16	16	16	16						
Equipped with Dozers	Clearing	12	12	5	5	5	5	5	5	3	3	3										15		10	10	10						
	Stripping			4	4	4	4	4	4	4	4	4	4	4										5	5	5						
	Drainage	1	1	1	1	1	1	1	1	1	1	1	1	1																		
	Excavation									1	1	1	1	1	5	5	7	7	7	7	7											
	Spreading									1	1	1	1	1	1	1	1	1	1	1	1											
	Haul roads	2	2																													
Towing 18 cu yd Scrapers	Stripping			4	4	4	4	4	4	4	4	4	4	2																		
	Excavation												6	6	10	10	10	10	9	9	9											
	Fine Grading																		1	1	1	1	1	1	1	1						
	Haul roads	1	1																													
Towing Sheepsfoot Rollers	Compacting									1	1	1	1	1	1	1	1	1	1	1	1											

REMARKS

DATE | TYPED NAME AND TITLE OF AUTHENTICATING OFFICER | SIGNATURE

Fig 1-4. Sample equipment requirement schedule.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. State the purpose of an equipment requirement schedule.

____

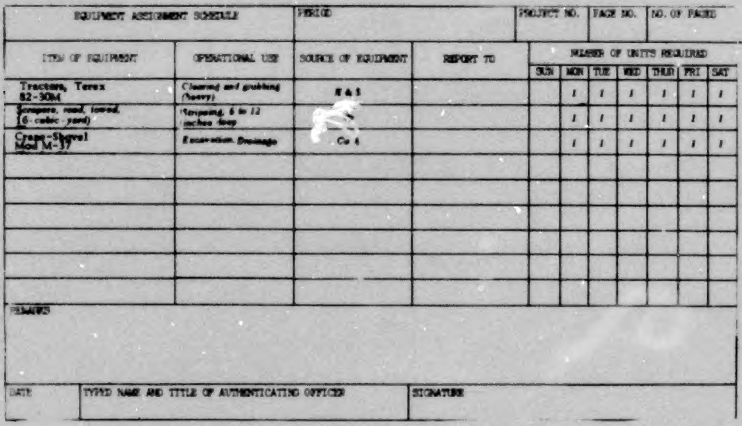
2. What should you do with equipment when one work item is ahead of schedule?

____

Work Unit 1-9. EQUIPMENT ASSIGNMENT SCHEDULE

STATE THE PURPOSE OF THE EQUIPMENT ASSIGNMENT SCHEDULE.

The equipment assignment schedule (fig 1-5) is a self-explanatory daily or weekly report which can be reproduced at the local level. The purpose of the schedule is to allow subordinate units to plan their equipment usage more efficiently.



EQUIPMENT ASSIGNMENT SCHEDULE		PERIOD		PROJECT NO.			PAGE NO.		NO. OF PAGES	
ITEM OF EQUIPMENT	OPERATIONAL USE	SOURCE OF EQUIPMENT	REPORT TO	NUMBER OF UNITS REQUIRED						
				SUN	MON	TUE	WED	THUR	FRI	SAT
Tractors, Terex 82-30M	Clearing and grubbing (heavy)	H & S			1	1	1	1	1	1
Scrapers, road, towed, (6-cubic-yard)	Stripping, 6 to 12 inches deep	[illegible]			1	1	1	1	1	1
Crane-Shovel Mod M-37	Excavation Drainage	Co A			1	1	1	1	1	1

REMARKS

DATE	TYPED NAME AND TITLE OF AUTHENTICATING OFFICER	SIGNATURE

Fig 1-5. Sample equipment assignment schedule.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. The Equipment Assignment Schedule is a(an) ________________ produced form.

    a. Marine Corps
    b. DOD
    c. locally
    d. Army

2. What is the purpose of the equipment assignment schedule?

    ____

Work Unit 1-10. CONSTRUCTION OPERATIONS SCHEDULE

LIST THE TWO SCHEDULES WHICH MAKE UP THE CONSTRUCTION OPERATIONS SCHEDULE.

Using the information from the work estimate sheet and the equipment assignment schedule, decisions are made as to what days will be spent on which operation. This information is entered on the construction operations schedule (fig 1-6) and serves as an operations control chart. By entering the progress made on each stage of the construction project day by day, the actual progress can be compared with the progress that was previously planned for the operation. In this way when one area of construction is lagging, additional equipment can be transferred from an area that is ahead of schedule. As mentioned before, the work estimate sheet, the equipment requirement schedule, and the construction operation progress chart are all dependent upon one another and are prepared simultaneously. It must also be noted that time should be allotted for the erection of camp sites, storage areas, and equipment such as rock crushers and saw mills.

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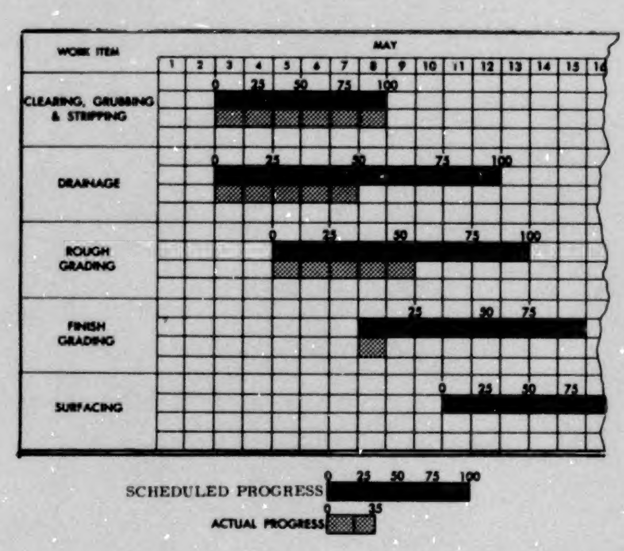


Fig 1-6. Construction operations schedule.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. List the two schedules that make up the construction operations schedule.

   a. ____
   b. ____

2. If one area of construction is behind schedule, what can be done to bring it back on schedule?

   ____

3. What is the purpose of the construction operations schedule?

   ____

Work Unit 1-11. PRODUCTION REPORTS

LIST THREE SIMPLIFIED METHODS OF REPORTING PRODUCTION PROGRESS.

The system of reports used in the field to record daily progress should not be so elaborate as to overload supervisors and operating personnel with administrative paperwork. But neither should the report system be so small that it would fail to give an adequate picture of the situation. Three types of reports that can be used for reporting production progress are daily, accumulative, and fragmentary.

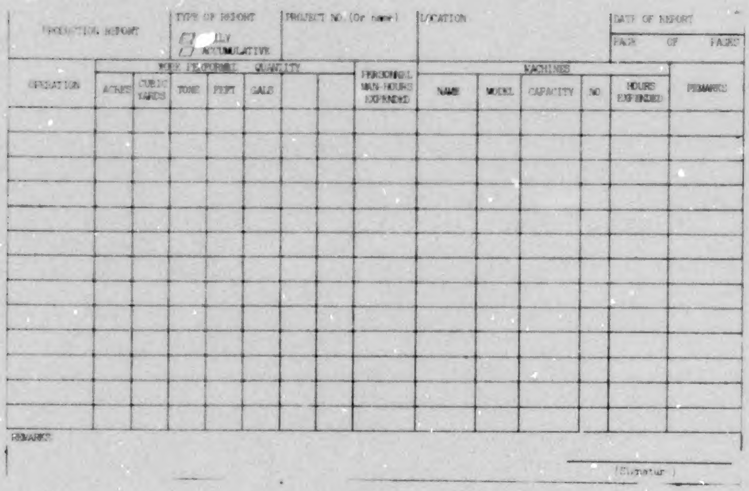
Daily production report. The report serves three useful purposes:

It indicates whether full use of men and equipment is made.

It is the basis for the preparation of the accumulative production report.

Together with the accumulative report it serves as an experience record which will assist in future planning and estimating of personnel and equipment.

Accumulative report. An accumulative report can be prepared to cover a certain period of time. Normally this report will show all the expenditures of man-hours and equipment-hours from the start of the project to the date of the report. All accumulative report information is collected by adding the data from the daily report. Such a report covers the project from start to finish. This information will serve as a valuable guide for future planning. The accumulative report can be prepared from the form shown in figure 1-7 and can be reproduced locally.



PRODUCTION REPORT	TYPE OF REPORT ☐ DAILY ☐ ACCUMULATIVE	PROJECT NO. (Or name)	LOCATION	DATE OF REPORT PAGE OF PAGES

OPERATION	WORK PERFORMED QUANTITY							PERSONNEL MAN-HOURS EXPENDED	MACHINES					REMARKS
	ACRES	CUBIC YARDS	TONS	FEET	GALS				NAME	MODEL	CAPACITY	NO	HOURS EXPENDED	

REMARKS

(Signature)

Fig 1-7. Sample, production report (daily and accumulative).

Fragmentary report. Fragmentary reports are normally made in the form of message summaries using the standard U.S. Marine Corps message form. This method is applicable to all types of reports normally used by engineers. It is a shortcut method and is used when required by fast-moving operations. Fragmentary reports provide pertinent, timely information and are transmitted in communication language. They may be required to be followed up by a written report.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. List three simplified methods of reporting production progress.

a. ____

b. ____

c. ____

Section III. SUPERVISION

Work Unit 1-12. PERSONNEL SUPERVISION

MATCH FIVE OF THE FACTORS OF GOOD PERSONNEL SUPERVISION WITH A DESCRIPTION OF THE FACTOR.

Supervision may be defined in a number of ways. The terms "management" and "administration" are related to and overlap supervision; in fact, supervision is a part of management. To direct and inspect the performance of workers (or work), is one definition of supervision. It is absolutely essential for a supervisor to be competent in his specialty. This alone however, will not get the job done. As well as knowing the job to be done, a good supervisor must know the capabilities of his men and must know the techniques of good supervision. Effective supervision consists of correctly organizing personnel, inspecting operations, personnel, equipment and materials, and maintaining morale.

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Defense and security of personnel and job. When operating in forward areas, security of the job and of the personnel is necessary to insure that the work schedule is not interrupted. If men believe that their security is being invaded, they will not produce to their maximum. (Enemy action will not necessarily decrease work output.) If an adequate warning and outpost system is employed, the working force might even increase production. It may be necessary to organize roving patrols for the security of the perimeters and interior defenses of the work areas. Security forces should be obtained from other than the working forces if possible. In the event of an enemy attack on the job site, every member of the working force should be assigned preplanned defensive positions. It cannot be overemphasized that any delay in the actual work schedule will result in the extension of the project completion date. As time is an important factor in combat, all methods of safeguarding the job site and work force should be exercised.

Morale. Morale, in the military sense, can be defined as mood or spirit of an individual or group with respect to performance and devotion to duty. A high state of morale is necessary to obtain maximum output of work over a period of time. Contentment of the men on the job does not indicate that their morale is high. A contented person is not necessarily a person whose morale is high. An example of contentment would be allowing personnel to arrive on the job late, to loaf during working hours, or to abuse equipment. Good morale stems from a sense of purpose in one's efforts, knowing that the work is important and understanding how it fits into the mission of the platoon or company. An individual's personal problems might be affecting his morale. By solving them or taking an interest in his problems, the morale of this individual may be raised. Competition with other units or against a time schedule can be useful in promoting high morale. Letting individuals see and understand that all are being treated equally and that each is sharing the workload will have an important bearing on the morale of the men. Try to make your crew have a sense of accomplishment; make them proud to be members of your platoon.

Health. Anything that affects or damages the health of a member of your crew, lowers his production output, which in turn will affect your completion schedule. The United States Marine is one of the world's best-fed, -clothed, and -equipped fighting men, but unless measures are taken to protect his health, all other privileges are useless. In the past decade, medical science has contributed many vaccines to prevent the spread of infectious desease, but sometimes even these are not enough. Bad living conditions, messing facilities, and sanitary conveniences can be the direct cause of a unit being incapacitated for duty. Personal inspections of living quarters, mess areas, and head facilities are one way to circumvent the loss of your working personnel. Personnel inspections to see that the troops are employing standard practices of hygenic living should be held periodically. If at all possible, shower facilities should be built. Any and all measures must be taken to protect your crew from anything that will be detrimental to the men's physical health or wellbeing. For personnel working in excess of 10 hours a day or performing strenuous work, extra rations should be allotted. Your job as a supervisor and a leader is the accomplishment of your mission on schedule, and unless you have the necessary personnel, this will be impossible.

Training. Training is of a continuous nature; it goes on all of the time. You train in preparation for a mission, continue training through the accomplishment of the mission, and then train until a new job is assigned. In general, training should be consistent with the following guidelines:

> It must be closely integrated and coordinated with daily operations of the unit. The plan and organization for training that is adapted must not interfere with essential construction functions.
>
> The construction schedule should not be so inflexible that it overlooks opportunities for training that might even expedite the construction schedule.
>
> Maximum advantage should be taken of the opportunity to derive training benefits from routine schedules.

A study of the job skills needed for a particular job will be the starting point for training. After you have made this study, an inventory should be made of the skills that your men possess. By comparing what you have with what you need, you will have an indication of the training needed to bring your unit up to the level required to complete the job. The operator of engineer equipment has a great responsibility. He must be able to move his equipment over rugged terrain and be able to operate it continuously for long periods of time. Continuous uninterrupted operation requires great skill and a considerable knowledge of the equipment. The training of an operator is a continuous process and does not stop when he receives an operator's permit. He must not only know how to operate his equipment, but he must also know how to take care of it and service it. He must know when to make minor adjustments, and when to recognize faulty performance. Since most engineer equipment is specialized in nature, and no person is a naturally qualified operator, the men must be trained by someone who has acquired the necessary skill to instruct and teach them these basics. The first step in selecting personnel to be equipment operators is the interview which should reveal the following factors:

The extent of his schooling and practical experience, both military and civilian.

With which items of equipment is he familiar?

What operator's licenses does he hold?

Undesirable attitudes he possesses such as resentment toward training, lack of interest, overconfidence or lack of confidence, aggressiveness or irresponsibility. He should be in good physical condition since operating equipment causes severe strain from vibrations. Fatigue leads to inefficient and dangerous operation of equipment.

Training is a command responsibility and the commander must make certain that training requirements necessary to promote the highest degree of combat readiness are met. To insure engineer personnel continue to maintain their proficiency along with the improvements of engineer equipment, training programs are instituted. There are basically four means of training available: formal training, correspondence training, factory schools, and on-the-job training.

On-the-job training. This type of training will probably be your most common training responsibility. OJT is basically intended to either improve the skills of the personnel while on the job or maintain the skills that they presently have. When operating on a strict time schedule, you would naturally assign your most experienced operators to specific jobs. When time is not an important factor, use the opportunity to train your inexperienced operators. OJT must be closely supervised to observe a man's weak points and strong points. Encourage the operators to ask questions. When deficiencies show up, correct them immediately. It is a recognized fact that when something is done wrong two or three times, it may become a habit. Also it is just as important to let a man know when he is doing right as when he is doing wrong.

Formal training. In general, this is usually conducted during normal working hours, or during days of enforced nonwork (inclement weather). Such training makes heavy use of the lecture and demonstration methods of instruction. It is group participation and usually takes place during regularly scheduled programs. For these types of classes, the instructors should be your most experienced men. Lesson plans and outlines are a must with this type of training as they show precisely what will be taught and how it will be taught. Formal military schools, which consists of full-time organized classes are also a part of the training program. Factory schools are often utilized to train personnel on specific items of equipment, such as, Caterpillar or Terex.

Correspondence training. Where proficiency is to be obtained with respect to the individual skills, correspondence schools such as MCI, Army, and Navy schools offer a wide variety of subjects, and participation in these off-duty studies should be greatly encouraged. These courses may be offered either on an individual or group participation basis.

Working conditions. Weather, climate, terrain, and safety precautions may greatly affect work output per man-hour. The normal rate of work can be reduced by insects, muddy or frozen ground conditions, and dense and tangled vegetation. Although you have no control over the weather or climate, there are little conveniences that can be obtained for the personnel, such as foul-weather gear when it is raining or warming tents when the weather is cold. In this way the troops know that although the job must be done you are making it as comfortable as possible for them. If men believe that the equipment or construction methods are unsafe, they will not produce to their maximum. Continued rains, snows, or intense heat will severely decrease the work rate. Working conditions should be improved as much as possible where the situation permits, even though working conditions in a combat situation at best are usually poor.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. List five of the factors of good personnel supervision.

    a. ______________________________
    b. ______________________________
    c. ______________________________
    d. ______________________________
    e. ______________________________

2. Working in a combat zone has no effect on labor output.

    a. True
    b. False

3. Why is it important for you as a supervisor to help solve or to take an interest in an individual's problems?

    ____

4. What method should be used to be sure your troops are employing standard hygienic practices?

    ____

5. When does training end for equipment operators?

    a. When they get their operator's permit
    b. When in a combat zone
    c. Never
    d. When the supervisor feels they are proficient

6. What effect could weather, climate, terrain, and safety precautions have on a project?

    ____

Work Unit 1-13. EQUIPMENT SUPERVISION

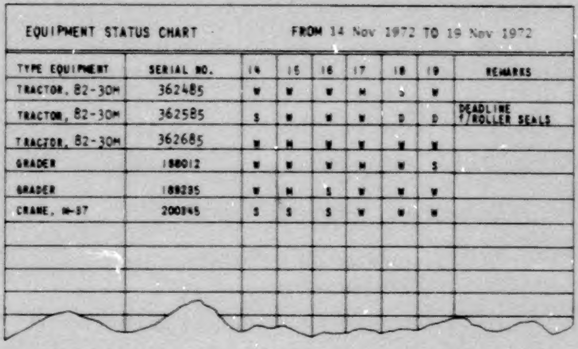
LIST THREE TECHNIQUES OF EQUIPMENT SUPERVISION.

One of the most important jobs of any supervisor is to keep a constant check on the equipment in addition to the personnel. If maximum effort is to be obtained on the job, each piece of equipment must be used to the best possible advantage and must be kept in good working condition throughout the entire operation. Personnel at all echelons must strive to prevent deterioration of engineer equipment and insure continuous efficiency and effectiveness. You, as the equipment chief, can obtain these results through inspections and well-organized maintenance programs.

Inspection. Thorough periodic and systematic inspections of equipment are essential to any engineer unit. This is the instrument by which you, as an equipment chief, can determine the serviceability of your equipment, the efficiency of the maintenance program, and the proficiency of your personnel. Frequent tours of inspection of the job site will give you the answer to most of your questions. Spot-check inspections will reveal whether the operators are performing daily preventive maintenance and observing operating and safety regulations. Inspection stations should be set up on the job site, utilizing part of your maintenance crew, to observe the equipment in operation. These teams can obtain valuable information on the maintenance and operation standards. The stations should be situated to facilitate observation of the equipment approaching, passing, and going away from the inspection station. In this way the inspection team may both observe the equipment and listen for noises that might be inaudible to the operator. The noises may be an indication of something in need of repair. At the same time defects that are minor now, but that will become major repair jobs if overlooked, may be corrected. Consider a comparatively insignificant factor like track tension. The equipment may be working in wet sand or mud and the tracks are tight instead of having a little slack in them; as this material packs between the chain and the bushing, track tension will build up, causing serious trouble. With just a few minutes of the operator's time, an adjustment can save you from losing a piece of equipment from the job.

Maintenance. Every operator is required to perform certain daily maintenance services on his equipment. Only by strict adherence to these services will the life of the equipment be prolonged. To avoid major breakdown of equipment, you, as the supervisor, should see that the operator not only performs these services, but repairs any defects that he is authorized to repair. Any defects of major concern should be reported immediately. It is essential that you make each operator aware of this fact and see that he meets his responsibilities in this regard. If more than one operator is assigned to a piece of equipment (such as in shift work) you must designate who is responsible for daily and weekly maintenance services. You must arrange for close liaison with the maintenance section, which has the mechanics who will handle repairs beyond that authorized by the operator. In most cases, major defects could be avoided by simple operator's adjustments or repairs. Effective maintenance decreases the requirements for extensive repairs at a higher echelon, resulting in savings in time, personnel, and money.

Maintenance schedules. Along with daily maintenance services, it is essential that the regularly scheduled maintenance services be performed. This schedule should be arranged so that all of your equipment is not tied up by maintenance at any one time. Staggering your services will do away with this problem. A working maintenance plan can be devised by referring to the equipment requirement and the equipment assignment schedules. The daily services can be taken care of during the four hours allotted between work shifts as previously stated. If time is not an important factor in the completion of a job, it should be noted that not all of your equipment should be assigned to the project. By keeping a certain portion of the equipment on standby status, in the event of equipment failure or breakdown, that part of the project will not be lacking for equipment, and can continue on schedule with the replacement from the standby equipment. The equipment assignment and equipment requirement schedules, the worksheet for Preventive Maintenance and Technical Inspection of Engineer Equipment (NAVMC 10560), and a simple Equipment Status Chart (fig 1-8) will show you the status of your equipment on any given day of the workweek.



EQUIPMENT STATUS CHART FROM 14 Nov 1972 TO 19 Nov 1972

TYPE EQUIPMENT	SERIAL NO.	14	15	16	17	18	19	REMARKS
TRACTOR, 82-30M	362485	W	W	W	M	S	W	
TRACTOR, 82-30M	362585	S	W	W	W	D	D	DEADLINE F/ROLLER SEALS
TRACTOR, 82-30M	362685	W	M	W	W	W	W	
GRADER	188012	W	W	W	M	W	S	
GRADER	188235	W	M	S	W	W	W	
CRANE, M-37	200345	S	S	S	W	W	W	

LEGEND: M Maintenance: W Working: S Standby: D Deadline

Fig 1-8. Sample, Equipment Status Chart.

The status report should be made up on a weekly basis, and it should show what piece of equipment is deadlined for major repairs, scheduled for routine maintenance, working, or on standby. Careful consideration of this report will indicate any additional equipment available and will tend to explain any equipment shortages. An excessive amount of equipment on deadline for a considerable period of time should be investigated, and corrective action should be taken when necessary.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. List three techniques of equipment supervision.

   a. ______________________________
   b. ______________________________
   c. ______________________________

2. How can you as an engineer equipment chief determine the serviceability of your equipment and the efficiency of your maintenance program?

   ____

3. Operators are allowed to perform maintenance on their equipment only when a mechanic is present.

   a. True b. False

4. What can the engineer equipment chief use to ensure all his equipment is not tied up with maintenance at one time?

   ____

Work Unit 1-14. JOB SUPERVISION

LIST TWO TECHNIQUES OF JOB SUPERVISION.

Supervision is probably more an art than a science. The same techniques that work well in one situation may have little application in a different situation. Knowing the job to be done is an important step in achieving maximum production. You should look at the job to be done and plan the sequence of operations. How much clearing will be required? Are there any drainage problems? What equipment is available, and what is its condition? You must evaluate your men. Are they experienced enough? Will you need additional men? How well you are able to carry out these steps is directly related to your ability to look at the situation and plan the steps that will bring you to your objective. A common failure of the supervisor is that of not delegating authority. You cannot possibly be in two places at the same time; there will be occasions when your presence is needed elsewhere when a problem occurs on the job. If this problem must wait until you are free, valuable time will be lost. It is important that you assign one or more of your NCO's to make decisions in your behalf. Here, knowledge of your men is an important factor. Some men can handle responsibility well; others cannot. In most cases, the senior NCO on the job is assigned this task, but it is necessary that whoever is assigned to this job be free to make decisions in your absence.

Personal inspection. Inspection of the construction site is necessary to see that the plans and directives are being followed. You cannot supervise operations from behind a desk. When a number of operations are in progress at the same time, it is necessary that these operations be arranged so that the work flow is uninterrupted. You should prevent scraper operators from bringing their equipment to the construction site before the dozers have had a chance to clear it. When constructing fills, a shovel should not be kept waiting for lack of trucks to haul the fill material. During these inspections you should see that equipment, labor, and materials are being used properly to insure timely completion of the project. Any conditions that were not anticipated during the planning phase should be noted and corrections taken to eliminate these conditions. These conditions are commonly known as bottlenecks.

Elimination of bottlenecks. Bottlenecks are a controlling factor or feature of a work item or project which cause a decrease in work output. They are held to a minimum by good prior planning, good coordination, and a quick change in plans when the situation warrants it. Bottlenecks are found by personal inspection, review, and analysis of progress records. They can be eliminated by good supervision and balancing of different work items on the job. Shifting equipment or personnel, addition of equipment (such as a pusher dozer to assist loading of tractor/scrapers to reduce loading time), smoothing hard roads that have become corrugated, or sprinkling water to settle dust are a few examples of procedures to eliminate bottlenecks. Every job has its particular problems, and the imagination and ingenuity of the supervisor concerned will determine how a particular problem will be solved.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. List two techniques of job supervision.

   a. ____________________
   b. ____________________

2. What is a common failure of the supervisor?

   ____

3. What can the supervisor do to insure that equipment, labor, and materials are being properly utilized?

   ____

4. How can bottlenecks be eliminated?

   ____

Work Unit 1-15. INSPECTIONS

STATE THE PURPOSE OF INSPECTIONS.

Thorough and systematic inspections of engineer facilities and equipment are essential to an effective maintenance program. Paragraph 4730 of the Marine Corps Manual, and directives promulgated by the Commandant of the Marine Corps require that commanders conduct scheduled inspections of their material and personnel. The importance of performing properly conducted inspections cannot be overemphasized. They are the instruments by which commanders at all echelons determine the serviceability of their equipment, the efficiency of their maintenance program, and the proficiency of their personnel. An inspection which is confined to the condition of equipment and which requires correction of the faults found, gives a commander an indication of the readiness of equipment to perform the mission for which it is designed. The larger the sample inspected, the more valid or reliable is the indication of readiness.

Objective. The purpose of inspections is to determine the following:

The serviceability, proper usage, and operational readiness of a unit's equipment.

The adequacy and effectiveness of organizational maintenance operations.

The efficiency of repair parts supply procedures, which directly support maintenance operations.

The proficiency of personnel.

The necessity for future maintenance personnel or supply requirements.

The action to be required from higher headquarters to assist units in improving their maintenance procedures.

Inspections of overall maintenance management and material readiness should include those areas stated above along with a review of repair parts requests and maintenance requests with a followup to supporting maintenance facilities. Each inspection should have a purpose. The results of the inspection should be critiqued with the responsible personnel of the inspected unit to insure that the original inspection objective has been reached.

Although maintenance inspections rely heavily on the condition of equipment, all elements which make up the maintenance effort should be examined, critiqued, and included in the inspection report. Results then are informative and may be utilized by interested members of the command. The inspected unit is given instructions on how to correct discrepancies which have been discovered, and followup action is taken to make sure that these deficiencies are corrected as soon as possible. Determination of deficiencies during inspections is meaningless unless specific action is taken to insure their correction.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. State the purpose of inspections.

____

2. Once an inspection is completed, what should be done to determine if deficiencies have been corrected?

____

Work Unit 1-16. FREQUENCY OF INSPECTIONS

STATE HOW OFTEN AN EQUIPMENT INSPECTION SHOULD BE HELD.

An inspection for inspection's sake may be worse than none at all. Most inspections are harassing to some degree, disrupt normal operations or schedules, and generally result in extra effort toward police, paper maintenance, and eyewash that add little to equipment readiness or productive maintenance. Except for the broad requirements that inspections be conducted periodically, CMC does not prescribe the frequency for maintenance management type inspections. Generally, command and maintenance inspections will be prescribed by directives from field commanders or other intermediate commanders. Commanders, in determining their own requirements for inspections, should consider the degree to which these inspections fulfill existing needs for the types information that these inspections provide. Duplication of effort, by conducting one inspection on the heels of another, may then be avoided both at the command level and the inspection level. The frequency of the commander's personal inspection will depend largely on the size of the organization. If conditions permit, the commander's personal inspection should be made often enough to demonstrate to the troops that emphasis is to be placed on preventive maintenance. The commander should have a plan to allow him, over a period of time, to inspect all of the equipment assigned to the unit. Unsatisfactory phases of inspections should be followed by reinspection within two to six weeks. The reinspection is not a duplication of effort in its effect on the inspected unit. It can be conducted by a subordinate to the initial inspection unit, but it should be at least one command level higher than the unit being reinspected. The time interval between inspections should be regulated by the benefits to be realized by the units and equipment being inspected and by the needs of the headquarters conducting the inspection. Inspections should not become a "rubber stamp" exercise. Consideration should be given to the "who", "what", and "how" elements even before the "when" element of a decision is made to conduct an inspection. Within a given organization, maintenance inspections should include samples of all types of maintenance equipment. Once a particular group of equipment has been found unsatisfactory, the point has been made. There is no need to beat a dead horse. The inspector should make sure that proper corrective action is understood, then he can move on to another area or equipment category. When a reinspection is necessary because of unsatisfactory conditions, the reinspection should be 100% by equipment categories. For example, if crawler-tractors are inspected within a company, and three out of four are found unsatisfactory, when reinspecting, all crawler-tractors should be inspected. By the same token, there is no need for 100% inspection of equipment and maintenance facilities which are obviously outstanding. After the fact has been established, a further inspection:

May be more profitably spent in examining other types of equipment or discussing problem areas.

Increases harassment.

Decreases the inspection productivity.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. State how often an equipment inspection should be held?

____

2. How soon after an inspection should unsatisfactory phases be reinspected?

____

3. During a reinspection, what percentage of unsatisfactory equipment categories should be checked?

____

Work Unit 1-17. TYPES OF INSPECTIONS

LIST THREE TYPES OF ENGINEER EQUIPMENT INSPECTIONS.

There are three types of inspections: command, technical, and spot-check. All inspections are technically a command function, since they always are conducted under command authority. However, the principal characteristic of the command inspection is that the commander personally participates. Technical and spot-check inspections are supplement to the command inspections. They provide an indication of whether or not deficiencies discovered during command inspections have been corrected.

Command inspections.

Purpose. During command inspections, the commander personally participates in the inspection of a subordinate unit or his own unit. This type of inspection provides the commander with a means by which he can determine the overall effectiveness of his organization. Although the inspection need not be too technical, it can be thorough enough to reveal major faults and any instances of neglect and carelessness. The technical and spot-check inspections, which are performed by qualified personnel, provide the commander with information on the detailed overall effectiveness of the unit. Commanders also utilize any technical or spot-check inspection which has been made within 90 days prior to the command inspection. There are two types of command inspection: informal and formal. The major difference between them is that the informal command inspection may be made at any time or place without prior notice.

Policy. General policies observed during a command inspection are:

The commanding officer of a subordinate unit being inspected is normally requested to accompany the inspecting officer.

Pertinent Marine Corps orders governing the standards of inspection are used.

The inspected unit in no case selects the equipment to be inspected.

The inspection team confines its inspection to deficiencies which impair or would bring about impairment of equipment operation.

Deficiencies noted during the inspection are brought to the attention of the responsible personnel at that time.

Upon completion of the inspection, the inspecting officer discusses the results with the commanding officer and the equipment officer of the inspected unit. The inspecting officer then indicates what corrective action is to be taken and furnishes needed advice and information.

Formal command. The formal command inspection involves advance notice and a set procedure. It normally applies to all phases of unit activity, including administration, personnel, and all types of equipment. This thorough inspection of the unit requires considerable time and preparation. It is preceded by the issuance of a training memorandum which includes such information as units to be inspected, personnel to conduct the inspection, manner in which the inspection will be conducted (including the specific way the equipment will be displayed), and the time and place of preliminary conferences. Although the commander personally participates, he employs inspecting parties to assist him with the inspection. These include technical assistants and various members of his staff; the specific composition of the party depends on the command level to be inspected. Since the unit being inspected is given advance notice and will have had considerable time for preparation, the results of this type of inspection do not present a true picture of the operating efficiency of the unit. However, the ability of the unit to properly prepare for the inspection and to meet the inspection party is one indication of the unit's morale, efficiency, and capabilities.

Informal command. The informal command inspection differs from the formal command inspection in that it is made at any opportune time or place, and it is usually given without notice to the unit to be inspected. This type of inspection is normally of greater value than the formal command inspection since it reveals to the inspecting officer the actual operating condition of the equipment and the operating proficiency of the personnel. Improper operating procedures and malfunctions may be promptly detected, and appropriate corrective action may be immediately taken.

Technical inspections.

Objective. Commanding officers having responsibility for field maintenance shall prescribe periodic technical inspections of using units. Although technical inspections are carried out in a manner similar to formal command inspections, they differ in that the commander does not directly participate. These inspections are made by technically qualified personnel under the direct supervision of technically qualified officers, assigned by the commanding officer, who are from a unit other than the one being inspected. The scope of the technical inspection includes a systematic inspection of the unit's facilities, tools, equipment, and personnel, and of the administrative procedures established for the performance of maintenance. The technical inspection also includes a detailed inspection of each type of engineer equipment. The primary purpose of the technical inspection is to determine the condition of the equipment and the adequacy and effectiveness of the maintenance and operational procedures. The technical inspection is a supplement to the command inspection. The inspecting personnel, possessing both technical knowledge and broad experience, can substantially aid the commander in perfecting his operations.

Procedure. The commanding officer determines the frequency of technical inspections and how much of the equipment is to be inspected. The organizational maintenance facilities, and at least 50% of each type of equipment in each unit is inspected annually. Since the inspections are performed at prescribed intervals, they are normally scheduled far enough in advance to make the necessary facilities and equipment available to the inspecting team. A complete list of all major items of engineer equipment, complete with the nomenclature, make, model, and serial number, are required to be maintained at all times by each unit, and a copy is furnished to the inspecting team at the time of the inspection.

Continuous spot-check inspections.

Objective. Commanding officers having responsibility for field maintenance for prescribing technical inspections, when necessary, prescribe spot-check inspections. The purpose is to determine the effectiveness of organizational and field maintenance and to determine whether or not corrective action required by previous inspections has been accomplished. The manner and the scope of the spot-check inspection are similar to that of the technical inspection. The frequency of spot-check inspections is determined by the field maintenance commander. The organizational maintenance facilities and at least 10% of each type of equipment in each unit are inspected annually. The inspection may be accomplished either with or without prior warning to the unit being inspected.

Procedure. The spot-check inspection procedures are the same as those used for technical inspections. Scheduling, conduct of inspection, and the reporting forms used are identical. The only differences between the two are that the spot-check inspection may be conducted without prior warning, and the percentage of equipment inspected is not the same.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. List three types of engineer equipment inspections.

   a. ______________________________
   b. ______________________________
   c. ______________________________

2. What are the two types of command inspections?

   a. ______________________________
   b. ______________________________

3. Which type of inspection includes a detailed inspection of each type of engineer equipment?

   ____

4. What is the major difference between a technical inspection and a spot-check inspection?

   ____

SUMMARY REVIEW

By studying the preceding work units you have learned the procedures for planning an engineer operation and for employing personnel and engineer equipment. You have become familiar with the proper use of job and equipment supervision. Further you know now about the purpose, frequency, and types of inspections used in an engineer organization.

Answers to Study Unit #1 Exercises

Work Unit 1-1.

1. During the planning phase
2. Determine the complexity of the work to be performed.

Work Unit 1-2.

1. a. Warm
   b. Light rains
2. Lowers efficiency
3. Topographic conditions
4. a. True

Work Unit 1-3.

1. Local supervision
2. a. Local labor
   b. Equipment
   c. Materials
3. Buildings, roads, quarries, water sources, equipment
4. Repaired and used if possible

Work Unit 1-4.

1. At brigade and higher levels
2. Unit task assignment.

Work Unit 1-5.

1. b. False
2. a. Routes
   b. Defensive positions
   c. Storage areas
   d. Natural material resources
3. b. False
4. To reduce the effects of enemy interference.
5. d. Storage areas

Work Unit 1-6.

1. 10 hours
2. a. Troop labor
   b. Civilian labor
   c. Prisoner-of-war labor
3. a. Loss of work efficiency
   b. Pilferage
   c. Sabotage
4. b. False

Work Unit 1-7.

1. a. True
2. a. 144 hours
   b. 2.25 days

Work Unit 1-8.

1. To show the amount of equipment needed for daily requirements.
2. Should be shifted to a work item that is lagging.

Work Unit 1-9.

1. c. locally
2. The equipment assignment schedule allows subordinate units to plan their equipment useage more efficiently.

Work Unit 1-10.

1. a. Work estimate sheet
   b. Equipment schedule
2. Equipment can be shifted from other areas that are ahead of schedule to help put the project back on schedule.
3. The construction operations schedule is used to monitor the progress of a construction project.

Work Unit 1-11.

1. a. Daily
   b. Accumulative
   c. Fragmentary

Work Unit 1-12.

1. a. Defense and security
   b. Morale
   c. Health
   d. Training
   e. Working conditions
2. b. False
3. May help raise morale.
4. Personal inspections
5. c. Never
6. Affects work output per man hour.

Work Unit 1-13.

1. a. Inspection
   b. Maintenance
   c. Maintenance schedules
2. Thorough inspections
3. b. False
4. A maintenance schedule

Work Unit 1-14.

1. a. Personal inspection
   b. Elimination of bottlenecks
2. Delegation of authority
3. Conduct personal inspections
4. By good supervision and balancing of work items

Work Unit 1-15.

1. To check the serviceability, proper useage, and operational readiness of a unit's equipment, and the proficiency of its personnel.
2. Follow-up action or reinspection

Work Unit 1-16.

1. Often enough to show troops that emphasis is to be placed on preventive maintenance.
2. 2 - 6 weeks
3. 100%

Work Unit 1-17.

1. a. Command
   b. Technical
   c. Spot-check
2. a. Formal
   b. Informal
3. Technical inspection
4. A spot-check inspection may be held without a prior warning.

STUDY UNIT 2

ESTIMATING EQUIPMENT EFFICIENCY

STUDY UNIT OBJECTIVE: UPON SUCCESSFUL COMPLETION OF THIS STUDY UNIT, YOU WILL BE ABLE TO STATE THE USE AND THE EFFICIENCY FACTORS OF EARTHMOVING EQUIPMENT. YOU WILL BE ABLE TO DESCRIBE THE APPLICATIONS OF CRAWLER AND WHEELED TRACTORS, SCRAPERS, ROAD GRADERS, AND CRANE-SHOVELS.

Section I. EQUIPMENT UTILIZATION

Work Unit 2-1. CRAWLER-TRACTORS

STATE THE PRIMARY USE OF A CRAWLER-TRACTOR.

Crawler-tractors are used where maximum power is required at relatively slow rates of speed. Crawlers are especially suited for sidehill excavation, and are preferred to the wheeled tractor for this type of work. The crawler-tractor has a bearing pressure of about 8 psi and has a flotation value over the wheeled tractor, which has a bearing pressure of from 25 to 35 psi. Crawler-tractors can operate in muck or water as deep as the height of their tracks. Operation in deep water for short periods of time is possible, provided that the tractor is properly waterproofed. For long moves, crawler-tractors should be transported by trailer. They may be moved under their own power at slow rates, but this decreases their operational life. The primary uses of the crawler-tractor are for short haul excavations and as auxiliary machines for other construction equipment.

The economical hauling distance for crawlers ranges from 25 to 300 feet. Dozers are most effective when operated at maximum practicable speeds and in soils which tend to stay in front of the blade. The selection of the type of dozer that is used on a job is governed by the type of work to be done. Figures 2-1 and 2-2 give the characteristics of tractors common to the Marine Corps.

Model	Weight	Blade Capacity cu. yd. (loose)
Terex 82-30M	53.560	7.9
Case MC 1150 Scooploader	26,700	1.44

Fig 2-1. Weight and blade capacities of crawler-tractors.

Model	Speed mph (DBPP)							
	Speed forward gears					Speed reverse		
	1st or Low-low	2d or Inter	3d or Hi	4th	5th	Low	Inter	High
Case MC 1150 Scooploader	0-2.02 (47,200)	0-3.52 (31,950)	0-4.25 (22,130)	0-6.82 (16,470)	X	0-2.43	0-5.10	0-8.22
Terex 82-30M	0-9.9 (120,000)	0-3.8 (60,000)	0-7.3 (27,000)			0-2.2	0-4.3	0- 8.3

Fig 2-2. Power characteristics of crawler-tractors.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. Why are crawler-tractors able to work in muck or water more efficiently than wheeled-tractors?

2. What is the primary use of crawler-tractors?

3. What determines the type of dozer to be used on a job?

Work Unit 2-2. WHEELED TRACTORS

DESCRIBE WHICH TYPES OF OPERATIONS ARE BEST SUITED FOR WHEELED-TRACTORS.

Wheeled tractors are used when hauls are long enough to develop high average haul and return speeds, or when crawler-tractors would be harmful to road surfaces. They are most effective on loam, gravel, or paved surfaces. Because of their rubber tires, wheeled tractors are not suitable for quarry work. Recent improvements in design give wheeled tractors almost the same traction capability under normal conditions as crawler types, but full drawbar pull cannot be obtained in sand or mud because of tire slippage. Slippage of tires on tractors pulling scrapers can be largely overcome by the use of a weight transfer device. This consists of a hydraulic cylinder connecting the scraper and tractor which transmits a predetermined portion of the weight from the front axles of the scraper to the rear axles of the tractor. Wheeled tractors have a greater speed and horsepower in relation to weight than crawler-tractors. Their highspeed mobility permits their use on widely separated tasks, such as prime movers for scrapers, where comparatively long hauling distances are involved. Their speed also increases the economical distance which may be traveled to obtain the type of fill materials required for a particular job. To get maximum drawbar pull and best performance, it is necessary to maintain correct tire pressure for the type of surface over which the tractor will be traveling. Consult the manufacturer's specifications for these pressures. Individual characteristics for certain makes and models of wheeled tractors are given in figures 2-3 and 2-4.

Make	Model	Weight (lb.)	No. of Wheels	Drive Wheels	Weight Distribution Front	Weight Distribution Rear
MRS without/ scraper	I-100-M-71	34,710	4	4 or 2	56%	44%
MRS	I-100 with 105-SM71	63,560	6	4 or 2	34	33/33

Fig 2-3. Characteristics of wheeled tractors.

Make & Model	Gears							
	Forward						Reverse	
	1st	2d	3d	4th	5th	6th	Low	High
MRS-I-100 X	4.4	6.26	8.8	12.4	17.6	25		
M71 XX	55,000	36,800	27,600	19,400	13,800	9,700	4.4	6.26

X Denotes speed in mph
XX Denotes drawbar pounds pull

Fig 2-4. Characteristics of wheeled tractors (power).

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. Describe the types of operations which are best suited for wheeled-tractors.

____

2. Because of their tires, which type of work is NOT suited for wheeled-tractors?

a. Gravel	c. Loam
b. Quarries	d. Paved surfaces

3. What is used to overcome slippage of tires on tractors pulling scrapers?

____

Work Unit 2-3. SCRAPERS

DESCRIBE WHEN SCRAPERS ARE MOST EFFICIENT.

Scrapers are large earthmoving machines capable of digging, loading, hauling, dumping, and spreading material. They make shallow cuts when loading, transport large loads, and spread materials in a thin, uniform layer. Scrapers are efficient when operated in light and medium soils which are relatively free of roots, stumps, and boulders. Heavy or consolidated soils require the additional use of pusher tractors to assist in obtaining maximum loads. In rough terrain, cuts are opened with dozers before scraper operations are started. Fine, dry sand is difficult to load because it will not pile up in the bowl, but will pile up in front of the apron. Wet clay and sticky soils are difficult to remove from the scraper because they tend to stick to the bowl. Most scrapers are built with open tops which make them suitable for top loading by clamshell, shovel, or chute. Power for operation of the scraper is provided by the towing tractor. There are three types of cutting edges for the bowl: the straight edge, which is most efficient for smooth finish work; the curved cutting edge, which provides better penetration than the straight edge; and the 3-piece cutting edge, with the center piece extending ahead of the two side pieces for improved penetration. Specifications for the MRS-105 SM-71 earth scraper are contained in figure 2-5.

Make & Model	Gross Weight (lb)	Capacity struck * (cu yd)	Capacity heaped * (cu yd)
MRS-105 SM-71	28,350	15.0	20.0

* Capacity given in loose cu yd

Fig 2-5. Specifications for earthmoving scrapers.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. Describe when scrapers are most efficient.

2. Why is fine, dry sand hard to load?

3. Name three types of cutting edges used on scrapers.

a.

b.

c.

Work Unit 2-4. CRANE-SHOVELS

STATE THE BASIC PURPOSE OF CRANE-SHOVELS.

A power crane and its attachments make up a versatile and important piece of equipment. Crane-shovels can be used for most types of construction work under varying conditions, but their basic purpose is to lift a load and place it in a new position. A power crane has three basic booms and six standard front-end attachments. The three basic boom types are; the backhoe, shovel, and lattice. The six standard front-end attachments that are used with these booms are; crane attachments (hook), clamshell, dragline, backhoe, shovel front, and pile driver. Figures 2-6 through 2-9 show the booms and attachments used with crane-shovels.

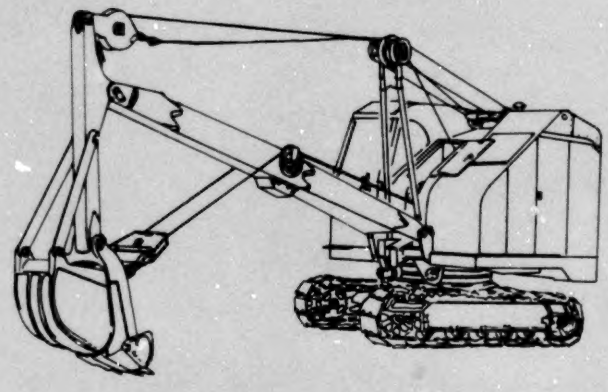


Fig 2-6. Crane with backhoe boom and attachments.

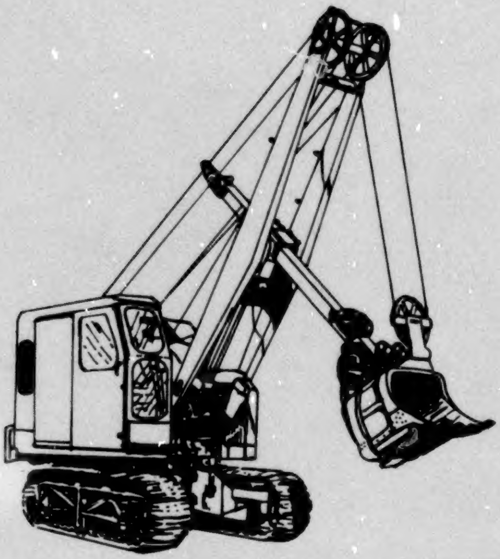


Fig 2-7. Crane with shovel front boom and attachments.

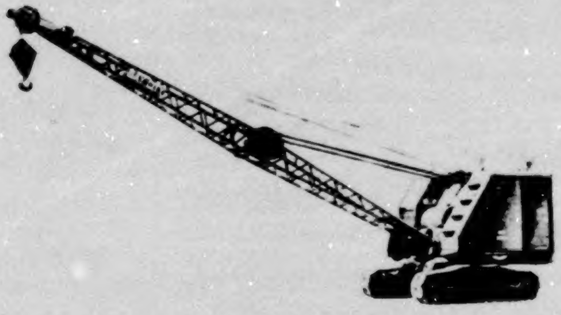
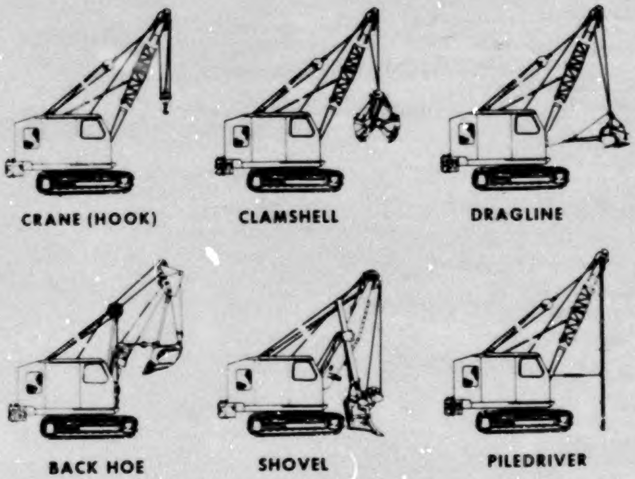


Fig 2-8. Crane with lattice type boom.



CRANE (HOOK)
CLAMSHELL
DRAGLINE
BACK HOE
SHOVEL
PILEDRIVER

Fig 2-9. Crane attachments.

During construction operations, you will be dealing, mostly, with shovel front, backhoe, clamshell, and dragline. You, as the equipment chief, will have very little to do with the actual operation of this equipment. Your principal duties will include determining the size shovel needed for a specific job, determining the hourly production rate, seeing that your operators use the proper techniques of shovel operation, and seeing that the job proceeds smoothly and efficiently. The best crane-shovel will not attain its maximum productivity unless it is properly supervised to coordinate the efforts of its crew. When supervising a crew, instruct the crew on proper operating techniques. Examples of proper operating techniques include:

Spotting the trucks or hauling units in a position to keep the swing angle at a minimum.

Changing the boom angle to suit the loading and dumping conditions.

Keeping the crane higher than the trucks, when loading from a shelf, so that the hoist can clear the trucks and return to a digging position.

In some operations, such as dragline work, you should plan the job thoroughly. Usually a dragline operation is an extended assignment, and the job site may be a considerable distance from the center of operations. Therefore, you must see that the crew has transportation to and from the job site and that an ample amount of fuel and supplies are available (parts, lubricants, and tools to make adjustments and maintain the machine). Some of the things to check for when supervising crane-shovel operations and when determining operating efficiency are:

Digging

Is the bucket or dipper full?

Are loads obtained by short, fast swings?

Would blasting increase loading speed and work output?

Is the best available accessory being used?

Is drainage complete?

Is face height adequate? (shovelfront only)

Swinging

Is swing as short as possible?

Are swing and dump combined into one motion?

Are trucks spotted to enable dumping with a slight retraction and minimum swing of bucket from the face?

Dumping

If dumping into trucks, is spillage kept to a minimum?

Is dump height as low as possible?

Does all the material leave the bucket?

Are hauling facilities adequate?

Is layer of dirt placed in the trucks before large boulders are loaded?

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. State the basic purpose of crane-shovels.

____

2. How many basic booms can be used with the crane-shovel?

a. 1
b. 2
c. 3
d. 4

3. Name the basic attachments that can be used on the crane-shovel.

a. ____
b. ____
c. ____
d. ____
e. ____
f. ____

4. The best crane-shovel will not attain its maximum productivity unless it is

____

Work Unit 2-5. GRADERS

DESCRIBE THE TYPE OF OPERATION BEST SUITED FOR ROAD GRADER.

Graders are multipurpose machines used for general construction and maintenance of roads and airfields. The grader can be used for leveling and crowning, mixing and spreading, ditching, sloping, and side casting materials. It can also be used for light stripping operations. Graders should not be used for heavy excavation. The Adams 550 grader was for several years the only grader used in the Marine Corps, but is now being replaced by the Caterpillar Series G grader. The major disadvantage of a motorized grader is that it is difficult to operate in heavy, wet areas. Where the material is hard and consolidated, it will be necessary to use the scarifying attachment prior to grading. Figure 2-10 lists the physical characteristics of the two road graders now found in the Marine Corps.

MAKE	MODEL	overall dimensions				Road Speed MPH										Engine Max BH. P. @ full load rpm	TYPE DRIVE
		Height		Length	Width												
		Less cab	With cab			first	second	third	fourth	fifth	sixth	seventh	eighth	Low Reverse	High Reverse		
12 ft. mold-board with scarifier. 12,500 to 14,475 lb pull: Adams	Diesel No. 550	7'8"	10'6"	25'5"	7'9"	2.4	3.3	4.7	6.5	7.9	10.8	15.8	24.0	3.5	5.0	100 @ 1,800	TANDEM
						(Forward and Reverse)											
12 ft. mold-board with scarifier. (DBP NOT AVAILABLE) Caterpillar	Diesel No. 130G	8'10"	10'11"	27'3"	7'11"	2.3	3.7	5.8	9.8	15.5	24.5	-	-			135 @ 2,200	TANDEM

Fig 2-10. Physical characteristics of road graders.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. Describe the type of operation best suited for road graders.

____

2. In what type of area(s) are graders hard to operate?

____

3. What is used to break up hard and consolidated material?

____

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Section II. EFFICIENCY FACTORS

Production estimation is very important in determining the number of pieces of equipment required and the best way to utilize equipment on the job. Estimated work output of a piece of equipment is determined in two ways:

By using a work output formula based on the cycle of operation and other factors which control production.

By using experience tables of average work output for different operations under varying conditions.

Output of earthmoving equipment is calculated by considering several factors in addition to equipment capacity, available power, and speed. These additional factors are: volume changes, rolling resistance, grade resistance, and altitude above sea level.

Work Unit 2-6. EQUIPMENT CAPACITY

CALCULATE, BY THE USE OF A FORMULA, THE CARRYING CAPACITY, IN CUBIC YARDS, OF EARTHMOVING EQUIPMENT.

CALCULATE, BY THE USE OF FORMULA, THE WEIGHT OF A LOAD.

In estimating equipment efficiency, the amount of material that a piece of equipment can haul or move must be known. If this information is not known, it can be obtained from the manufacturer's specifications. The carrying capacity of earthmoving equipment is measured in loose cubic yards. Bank yards are converted to loose yards to determine the amount of earthmoving equipment required to handle the material.

Load per cycle. This is the amount of loose soil, measured in cubic yards (cu yd), that can be transported by an item of equipment during one round trip.

Conditions. In earthmoving operations, it is necessary to consider volume changes in earth caused by handling. If you dig a hole in common earth and then fill the same hole with the earth that you removed, you would have some left over. If, however, you stamped and compacted the earth, it would not fill the hole. The increase in volume of earth that results when it is dug from its natural state is called swell. The digging process loosens the earth and increases the size of the voids between the particles. Common earth has an average swell factor of about 25% (fig 2-11). One cubic yard of common earth will occupy 1.25 cu yd of space when removed. Shrinkage is the term used to denote the decrease in volume that takes place when the earth is properly compacted. Figure 2-12 gives soil conversion factors for earth volume changes. Excavation and fill are calculated on the basis of loose yards, in-place or bank yards, and compacted yards under the following conditions:

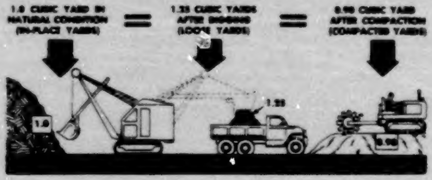
1.0 CUBIC YARD IN NATURAL CONDITION (IN-PLACE YARDS)
=
1.25 CUBIC YARDS AFTER DIGGING (LOOSE YARDS)
=
0.90 CUBIC YARD AFTER COMPACTION (COMPACTED YARDS)
1.0
1.25
0.90

Fig 2-11. Volume change in earth caused by handling.

Loose yards are used to express the carrying capacity of the equipment.

Bank yards are converted to loose yards to determine the amount of equipment required to handle the material.

To determine the amount of material needed in a fill, bank yards must be converted to compacted yards.

The output of equipment in loose yards must be converted to compacted yards to determine the final volume of fill.

Soil type	Soil condition initially	Converted to		
		Bank	Loose	Compacted
Sand	Bank	—	1.11	0.95
	Loose	.90	—	.86
	Compacted	1.05	1.17	—
Loam	Bank	—	1.25	0.90
	Loose	.80	—	.72
	Compacted	1.11	1.39	—
Clay	Bank	—	1.43	0.90
	Loose	.70	—	.63
	Compacted	1.11	1.59	—
Rock (blasted)	Bank	—	1.50	1.30
	Loose	.67	—	.87
	Compacted	.77	1.15	—
Hard coral (dead) Comparable to Limestone	Bank	—	1.50	1.50
	Loose	.67	—	.87
	Compacted	.77	1.15	—

Fig 2-12. Soil conversion factors.

Example: Determine the compacted volume that a 15-yd MRS-105 SM-71 scraper can haul per cycle when fully loaded with dry clay.

Solution: From figure 2-5, it is found that this scraper can haul 20 cu yd of loose dry clay. The conversion factor from loose to compacted clay is given as 0.63 in figure 2-12.

Formula: a x b = c

a = size of load
b = conversion factor
c = compacted volume in cubic yards

Thus: Compacted volume per cycle = 20 x 0.63 = 12.60 cu yd

Weight of materials (fig 2-13). Weight as well as conditions of materials must be known so that the equipment assigned will be able to handle the job. This will tend to speed production and protect the equipment from overburdening.

Material	Weight lb/cu yd loose	Material	Weight lb/cu yd loose
Cinders	1,080 - 1,220	Limestone	2,560
Clay, dry	1,770	Sandstone	2,220
Clay, wet	2,980	Sand, dry	2,430 - 2,840
Clay and gravel dry	3,240	Sand, wet	3,240
Gravel, dry	2,430 - 2,840	Shale	2,480
Gravel, wet	3,240	Slag, bank	1,800 - 1,940
Earth loam, dry	1,950 - 2,160	Slate	2,500
Earth loam, wet	2,960 - 3,240	Trap rock	2,700
Hardpan (mixture of compacted gravel, sand and clay)	3,100	Coral (hard)	2,030 - 2,440
		Coral (soft)	1,760 - 2,030

Fig 2-13. Approximate weight of materials.

Example: Determine the weight of dry clay that a 15-yd MRS-105 SM-71 scraper can haul per cycle when fully loaded.

Solution: Figure 2-13 gives the weight of dry clay as 1770 lb per loose cu yd. From the previous example, you learned that this scraper will carry 20 cu yd of loose dry clay.

Formula: a x e = f

a = size of load
e = weight in pounds of one cubic yard
f = weight of load in pounds

Thus: Weight of the load = 1770 x 20 = 35,400 lb per load

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. Name the increase in volume of earth dug from its natural state.

____

2. Calculate, using the formula given above, the compacted volume that a 15-yd MRS-105 SM-71 scraper can haul per cycle when fully loaded with dry loam.

____

3. Calculate, using the formula given above, the weight of the load in question 2.

____

Work Unit 2-7. CYCLE TIME

CALCULATE, BY THE USE OF A FORMULA, THE CYCLE TIME OF ENGINEER EQUIPMENT.

Cycle time is the time required to load, haul, dump, and return. There are two types of cycle time: fixed and variable. It should be remembered that the speed during hauling is normally different than the return speed. The total cycle time equals the variable time plus the fixed time.

Fixed time. Fixed time is the time spent during an equipment cycle in other than hauling or returning. It involves the time spent for loading, turning, acceleration, deceleration, and dumping. All of these factors are fairly constant or fixed and change little from project to project, regardless of the haul length. It should be pointed out that these times are given as a guide only. Typical fixed times are given in figure 2-14.

Wheeled tractor/scraper combinations (with pushers)	Basic fixed time constants for ____		
	5th gear haul	4th gear haul	3d gear haul
Loading	1.0 min	1.0 min	1.0 min
Dumping and turning	0.5 min	0.5 min	0.5 min
Acceleration and deceleration	1.5 min	0.8 min	0.4 min
Total fixed time	3.0 min	2.3 min	1.9 min
Crawlerdozers (shuttle dozing only):	Using same transmission, shifting only w/ forward-reverse lever		With transmission shifted to higher gear when in reverse.
Total fixed time-one cycle	0.10 min		0.20 min
Crawler tractor/scraper Combinations	Self-loading		Push-loaded
Loading	1.5 min		1.0 min
Dumping and turning	1.0 min		1.0 min
Total fixed time	2.5 min		2.0 min

Fig 2-14. Fixed-time constants.

Variable time. This is the actual time spent on the road transporting material to the fill site and returning with the empty vehicle. The time required to do this varies depending on the distance to the fill and the speed at which the hauling unit travels. Variable time is found by using the formula:

$$\text{Variable time (min)} = \frac{\text{haul distance in feet}}{\text{speed in mph} \times 88}$$

Note: 88 is a conversion factor from mph to feet per minute.

Since speed is determined by power requirements and limitations, and is established by gear selection, it is possible to haul in one gear, and return in another. The variable-time formula must be applied to both the haul and return times.

Total cycle time. As stated previously, the total cycle time is the result of the addition of fixed and variable times. An illustration of this would be:

> An MRS-I-100 with a MRS-105 SM-71 scraper hauls 7,500 ft to fill using 3d gear at 8.8 mph. It returns by a different route, traveling in 4th gear at a speed of 12.4 mph for a distance of 8,200 ft. What is the total cycle time per trip?
>
> Formula: $F + V_1 + V_2 = T$
>
> F = fixed time (min) = 1.9 (fig 2-14, 3d gear haul)
>
> V_1 = variable time (min to fill area) = $\frac{7{,}500}{8.8 \times 88} = 9.7$ min
>
> V_2 = variable time (min for return trip) = $\frac{8{,}200}{12.4 \times 88} = 7.5$ min
>
> T = total time per cycle = 1.9 min + 9.7 min + 7.5 min = 19.1 min

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. What is cycle time?

____

2. The time spent during an equipment cycle in other than hauling or returning is known as

____

3. Calculate, using the formula given in the text, the total time per cycle of the example given below.

> An MRS-105 SM-71 scraper hauls 9,000 feet to fill using 3d gear at 8.8 mph. It returns by a different route, traveling in 4th gear at a speed of 12.4 mph over a distance of 10,500 ft. Fixed time (min) = 1.9 min (3d gear haul).

____

Work Unit 2-8. ROLLING RESISTANCE

CALCULATE, BY THE USE OF A FORMULA, ROLLING RESISTANCE.

Definition. Rolling resistance must be considered for wheeled prime movers, but not for track-type movers. Rolling resistance is the resistance to movement by wheeled equipment due to irregularities in the road surface, compaction and displacement of the materials over which the hauling units must travel, and the flexing of the sidewalls of the tires. It is measured by drawbar pull, in pounds per short ton (DBPP) (lb/ton) of gross weight. Figure 2-15 gives typical rolling resistance factors.

A hard, smooth stabilized roadway without penetration under load (concrete or blacktop).	40 DBPP/ton
A firm, smooth-rolling roadway flexing slightly under load (macadam or gravel-topped road).	65 DBPP/ton
A rutted dirt roadway, flexing considerably under load (hard clay road, 1" or more tire penetration).	100 DBPP/ton
Rutted dirt roadway, no stabilization, somewhat soft, under travel (4" to 6" tire penetration).	150 DBPP/ton
Soft, muddy, rutted roadway, or in sand.	200 to 400 DBPP/ton

In the absence of the above data the following formula may be used:

Rolling resistance factor = 40 lb/ton + 30 lbs/ton per inch of tire penetration

Fig 2-15. Rolling resistance factors.

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Formula. Rolling resistance equals the gross weight of the rolling unit, measured in tons, multiplied by the rolling resistance factor.

$$R = \frac{Wr}{D}$$

R = total rolling resistance
W = total weight
D = drawbar pull in lb/ton (2,000)
r = resistance factor (fig 2-15)

Example. Determine the rolling resistance for an MRS-I-100 tractor/scraper traveling over a gravel road (little flexing). Weight of the soil in the scraper is 27,000 lb. The weight of the MRS-I-100 M71 is 34,710 lb (fig 2-3). The weight of the scraper (fig 2-5) is 28,850 lb. Combined, the weights equal 63,560 lb.

Weight of soil = 27,000 lb
Weight of tractor = 34,710
Weight of scraper = 28,850
Total weight = 90,560 lb
Rolling resistance = 65 DBPP per ton (fig 2-15)
Total rolling resistance = $\frac{90,560 \times 65}{2,000}$ = 2,943 DDPP

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. How is rolling resistance measured?

   a. Feet per square yard
   b. Foot pounds
   c. Drawbar pull
   d. Cubic yards

2. Calculate, using the formula given in the study unit, the rolling resistance for an MRS-I-100 tractor/scraper traveling over a paved road. Weight of the soil in the scraper is 32,000 lb.

Work Unit 2-9. GRADE RESISTANCE

CALCULATE, BY THE USE OF A FORMULA, GRADE RESISTANCE.

Definition. Grade resistance is the decrease in, or the addition of, the amount of drawbar pull required because of the adverse or favorable grades of a haul road. The generally accepted measurement of the effects of grades are: Each 1% of adverse grade consumes 20 lb. of drawbar pull per short ton of gross weight. Each 1% of favorable grade decreases the drawbar pull required by 20 lb per short ton of gross weight.

Formula: $P = \frac{Wbg}{D}$

P = pounds pull required
W = gross weight
D = short ton (2,000 lb)
b = lb of DBP (20)
g = grade percent

Example. The total weight of a tractor and loaded scraper is 90,560. Determine the pull required to climb a 3% adverse slope.

$$P = \frac{90,560 \times 20 \times 3}{2,000}$$

P = 2,717 DBP

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. What is the generally accepted measurement of the effects of grades?

____

2. Calculate, using the formula given in the work unit, the grade resistance when the total weight of a tractor and loaded scraper is 95,560 lb. Determine the pull required to climb a 5% adverse slope.

____

Work Unit 2-10. ALTITUDE

CALCULATE, BY THE USE OF A FORMULA, THE EFFECT ALTITUDE HAS ON THE EFFICIENCY OF INTERNAL COMBUSTION ENGINES.

Effects. Elevation above sea level has adverse effects on the efficiency of internal-combustion engines. This effect is negligible for altitudes up to 3,000 feet above sea level. A generally accepted rule of thumb estimates the reduction in available drawbar pull at 3% for each 1,000 ft of elevation, or fraction thereof, in excess of 3,000 ft above sea level.

Example. Determine the available drawbar pull for a Terex 82-30M dozer operating at an altitude of 7,000 ft for low and intermediate respectively?

Formula: $a - b = c$

$\frac{c}{d} \times e = f$

$g - f = h$
$h \times i = j$

Where: a = working elevation
b = elevation below which altitude has a negligible effect (3,000 ft)
c = elevation efficiency effects on engine
d = 1,000 ft elevation (constant)
e = 3% decrease in power (DBPP) per 1,000 ft of elevation
f = total % decrease in power
g = 100% (constant)
h = total % power available
i = total DBPP (fig 2-2)
j = available DBPP

Solution: $a - b = c$ 7,000 ft - 3,000 ft = 4,000 ft

$\frac{c}{} \times e = f$ $\frac{4,000}{1,000} \times 3\% = 12\%$

$g - f = h$ 100% - 12% = 88%

$h \times i = j$ 88% x 120,000 = 105,600 DBPP available in low range

88% x 60,000 = 52,800 DBPP available in intermediate range

EXERCISE: Answer the following question and check your response against the one listed at the end of this study unit.

1. Calculate, by the use of the formula, the effect altitude has on the internal-combustion engine in the problem below.

Determine the available DBPP for a Case MC 1150 scooploader operating at an altitude of 5,000 ft for intermediate and high.

____

Work Unit 2-11. TRACTION LIMITATION

CALCULATE, BY THE USE OF A FORMULA, THE USABLE POUNDS DRAWBAR PULL OF A TRACTOR.

Definition. Traction is the frictional force that resists the wheels or tracks from slipping on a particular soil. It depends on the weight of the drive wheels and the tractional coefficient of the soil (fig 2-16). The maximum pull a tractor can exert before spinning can be given as follows: Usable pounds pull equals the coefficient of traction times the weight on the drive wheels. Thus, the usable pounds pull must be equal to or greater than the drawbar pounds pull required.

Material	Rubber tires	Tracks
Concrete	.90	.45
Clay loam, dry	.55	.90
Clay loam, wet	.45	.70
Rutted clay loam	.40	.70
Loose sand	.30	.30
Quarry pit	.65	.55
Gravel road (loose not hard)	.36	.50
Packed snow	.20	.25
Ice	.12	.12
Firm earth	.55	.90
Loose earth	.45	.60

Fig 2-16. Coefficients of traction for tractors.

Example. Determine the usable pounds drawbar pull for an MRS-I-100 rubber-tired tractor on wet clay using 2-wheel drive.

Solution. From figure 2-3:
weight of tractor = 34,710 lb
weight distribution = 44% on rear wheels
weight on drive wheels = 34,710 x .44 = 15,272 lb

From figure 2-16:
maximum coefficient of friction = .45
usable lb pull = 15,272 x .45 = 6,872 DBPP

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. Define traction.

2. Calculate, using the formula given in the work unit, the usable pounds drawbar pull for an MRS-I-100 rubber tired tractor on loose sand.

Work Unit 2-12. OPERATIONAL EFFICIENCY

STATE THE OPERATIONAL EFFICIENCY OF CRAWLER TRACTORS.

STATE THE OPERATIONAL EFFICIENCY OF WHEELED TRACTORS.

Seldom, if ever, does a unit reach maximum production. This is due to reasons such as a supervisor's lack of know-how, a poor state of maintenance of the equipment, and deficiencies in the operator's skill and techniques. The equipment efficiency factor must be estimated, and it must be considered because of the fact that a piece of equipment cannot work a full 60 minutes out of every hour. This efficiency varies depending upon the supervision, the ability of the operators, maintenance requirements, and site conditions. Thus, an efficiency factor is multiplied by the maximum production to obtain the estimated production for the project. This factor should be computed from past experience by the unit. For the purpose of this course, we will use the following efficiency factors:

Day. The efficiency factor for track-type tractors during daylight hours is estimated at 83% with the tractor working 50 min/hour. The efficiency factor for wheeled tractors during daylight hours is estimated at 75%, working 45 min/hour.

Night. During hours of darkness, even with the aid of night-lighting equipment, this factor will decrease along with the output of work per hour. For track-type tractors, the efficiency factor decreases to 75% as the work output falls to 45 min/hour. The wheeled tractor efficiency decreases even more, down to 67% with only a total of 40 min/hour of working time.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. State the operational efficiency factor of tracked and wheeled tractors during daylight hours.

   a. Tracked____________________

   b. Wheeled____________________

2. During hours of darkness, will the efficiency factor increase or decrease?

   ____

Section III. CRAWLER-TRACTOR APPLICATIONS

Work Unit 2-13. CLEARING AND GRUBBING

STATE THE PURPOSE OF A LAND CLEARING OPERATION.

STATE THE PURPOSE OF A GRUBBING OPERATION.

Land clearing is a construction operation consisting of clearing an area of all trees, downed timber, brush, rubbish, surface boulders, and material imbedded in the ground. Disposing of the material cleared is also part of the operation. Grubbing consists of the removal of particularly stubborn roots and stumps. In most cases, the use of engineer equipment is the most rapid and efficient method of clearing. Hand or power felling equipment, explosives, and fire are used as applicable to help complete the operations. Factors determining the method to be used are: The acreage to be cleared, type and density of the vegetation, the terrain, the availability of personnel and equipment, and the time available for completion of the operation. In clearing an area through a forest, the dozer is the most efficient type of equipment for removing small trees and brush, and uprooting stumps, roots, and trees up to 10 inches in diameter. After the boundaries of the clearing have been established, spoil areas are designated on the basis of the following factors: shortest haul, downgrade slope, effective camouflage, and general accessibility. In clearing small trees and brush, dozers should operate in first or second gear with the blade straight and digging slightly below ground level. This will uproot and break off a number of small trees and brush. Dozers can work singly or in pairs, and the cleared material can be pushed into windrows or to one side of the area to be cleared to await disposal. Using this method, approximately 1,000 sq yd can be cleared per hour per machine. Using one or two dozers for the small trees and brush, a second pair of dozers can follow and remove large trees and stumps that were previously passed up by the first team. If necessary, a third pair may be added to assist in removing heavy timber (trees having a diameter of 10 or more inches). Removal of heavy timber is slower and more difficult, usually taking from 5 to 20 minutes per tree. Special precautions must be taken when removing these trees, since falling branches will endanger the equipment operators and rising root masses may catch and seriously damage the underside of the equipment. No two units should work too close together as one may accidentally push a tree onto the other operator. After the clearing is completed, all holes left by the removal of trees should be filled-in to prevent the accumulation of water. The speed of clearing depends on the type of clearing to be done, output of equipment, and the methods used. Production rates of equipment under normal operating conditions are used to determine the total time required for the job. Knowing the area and type of clearing, and the production rates of the available equipment, the time can be estimated and a job schedule prepared.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. State the purpose of a land clearing operation.

   ____

2. State the purpose of a grubbing operation.

   ____

3. What safety precaution should be taken when two or more dozers are working together, removing larger trees?

____

Work Unit 2-14. STRIPPING AND BACKFILLING

STATE THE PURPOSE OF A STRIPPING OPERATION.

NAME THE TYPE OF EQUIPMENT BEST SUITED FOR BACKFILLING.

a. Stripping. Dozers are used to clear and strip well ahead of earthmoving operations, particularly in excavation areas, so that the soil will have a chance to dry out. Stripping is the removal and disposal of objectional topsoils and sods. These operations are planned to minimize haul distances; maximum haul distance is 300 ft. In rough or steep terrain, haul distances may be longer. If so, the topsoil should be fed downgrade to open areas so that scrapers or other hauling units may be utilized for the removal of the material. Stripping should be planned so that excavation can begin as soon as possible.

b. Backfilling. Dozers are the best equipment for backfilling because the material is pushed directly ahead of the machine over banks, into ditches, or directly against a structure. When backfilling culverts, dozers should not be allowed to cross the structure unless there is at least 12 in. of solid material on top of it. Angle dozers are excellent for this operation since they can drift material into the fill area while still maintaining their forward progress. When the distance is over 300 ft, it is more efficient to haul with scrapers directly to the dozers at the fill site. This will keep the dozers working continuously with little loss in production time. When compaction of the backfill area is necessary, layers of 6 to 12 in. thick are built up. Having the operators overlap their tracks will aid in compaction and less time will be required for final compaction. Care must be taken when compacting over culverts and buried structures so that damage will not occur.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. State the purpose of a stripping operation.

____

2. Name the type of equipment best suited for backfilling.

____

3. When backfilling culverts, how many inches of soil should there be on top before allowing dozers to cross?

____

Work Unit 2-15. SIDEHILL EXCAVATION

STATE WHICH TYPE OF DOZER IS BEST SUITED FOR SIDEHILL EXCAVATION.

One of the most important uses of a dozer is sidehill excavation for road construction. An angle dozer is best for this operation which includes preparation of level benches on which scrapers can operate. Dozers should work from the top down, taking advantage of the favorable grades, thereby increasing production. On a particularly steep slope it may be necessary to start above the proposed roadway and doze downhill to form a shelf or bench from which it can work as shown in figure 2-17. Starting from the top, where possible, with the blade angled so that the leading edge is toward the bank, the operator obtains a load. The side casting action of the angled blade will deposit material on the low side of the slope. After dumping the spoil, the operator backs up in the fastest safe speed possible. If the project calls for a specific bank slope on the sidehill cut, the following procedure should be used. Make the first pass and then move out whatever distance is necessary to carry the slope. Always maintain the slope as the cut increases in depth. Where it is possible to start at the bottom, keep the blade raised as high as possible and hold it against the slope. Cast the material to the outside to build the ramp for the machine to work on as it progresses up the hill. Always keep the inside or bank side lower than the outside edge, eliminating dangerous overhangs. Operators must watch for underground rocks when starting a narrow sidehill cut. If the corner of the blade hits a buried rock, it may turn the tractor sideways and throw it over the bank. Use experienced operators only on sidehill excavation work.

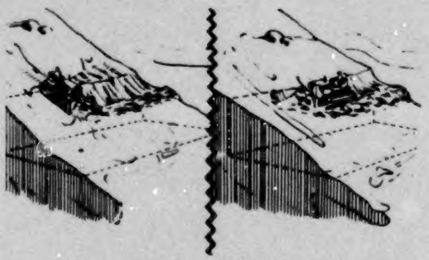


Fig 2-17. Sidehill excavation with angle dozer.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. State the type of dozer which is best suited for sidehill excavation.

2. Which way should the spoil be cast on sidehill excavations?

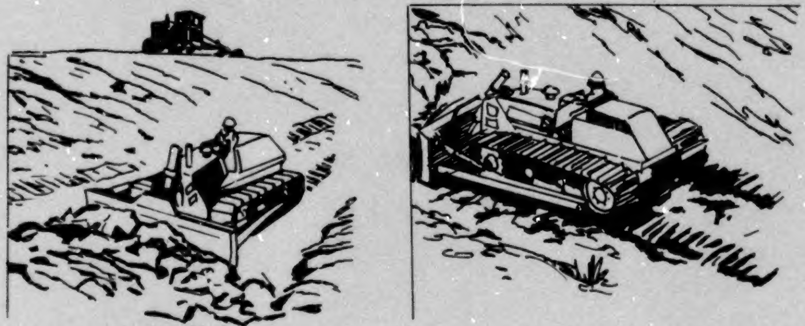
Work Unit 2-16. FINISHING SIDE SLOPES

LIST TWO METHODS OF FINISHING SIDE SLOPES.

Two commonly used methods for finishing side slopes with dozers are illustrated in figure 2-18.

Parallel finishing. In finishing side slopes by working parallel to the right-of-way, the dozer starts at the top and with each successive pass spills the soil to the lower side of the blade. This forms a windrow which in turn is picked up on the passes that follow. This material is used to fill irregularities in the terrain. Care must be taken not to let the blade corner dig since this will steepen the slope beyond job specifications.

Diagonal finishing. In finishing side slopes by the diagonal method, the dozer starts at the bottom and works up diagonally to the right-of-way. A windrow is formed and is continually drifted to one side to fill in terrain irregularities. This is one of the few instances when a dozer may be most efficient at cutting uphill.



Parallel

Diagonal

Fig 2-18. Finishing side slopes with dozers.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. List two methods of finishing side slopes.

   a. ____

   b. ____

2. Name the type of finishing used when a tractor starts at the bottom and works up to the right-of-way.

   ____

Work Unit 2-17. METHODS TO INCREASE PRODUCTION

LIST THREE METHODS TO INCREASE PRODUCTION OF BULLDOZERS.

Blade-to-blade dozing (fig 2-19). This gives increased output when material is to be moved distances of 50 to 300 feet. At distances less than 50 feet, the extra yardage obtained is offset by the extra time required to maneuver the second dozer into position. More than two dozers may be used effectively. Blade-to-blade dozing has limitations caused by the tendency of the operators to stop and talk and wait for minor repairs or adjustments to the adjacent machine.

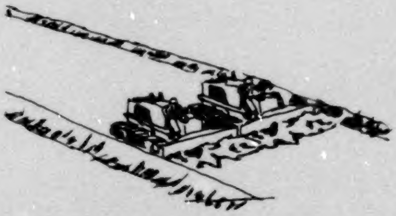


Fig 2-19. Blade-to-blade dozing.

Slot dozing (fig 2-20). Slot dozing uses spillage from the first few passes to build a windrow on each side of the dozer's path. This forms a trench and prevents spillage on the passes that follow. Cut sections should be slotted alternately with narrow uncut sections between the slots. These can be removed with normal dozing. With a favorable grade and soil conditions, the production increase may amount to as much as 50%.

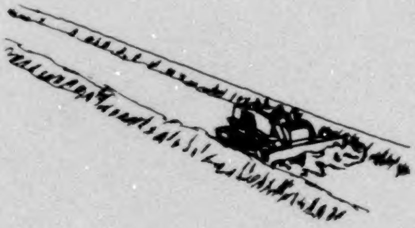


Fig 2-20. Slot dozing.

Downhill dozing. In downhill dozing it is not necessary to carry each load down to the bottom of the hill. Several loads can be piled at the brink of the hill and pushed to the bottom in one pass. Whenever feasible, dozing should be done downhill to take advantage of the fact that a favorable grade will increase the ability of the dozer to use its full amount of drawbar horsepower, thus increasing production. Combinations of any of these three methods can be used to increase production.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. List three methods to increase the production of bulldozers.

   a. ______________________________

   b. ______________________________

   c. ______________________________

2. With favorable grade and soil conditions, slot dozing can increase production by ______%.

3. Which type of dozing should be used to take advantage of a dozer's full amount of drawbar horsepower?

   ____

Work Unit 2-18. PRODUCTION ESTIMATION FOR CRAWLER-TRACTORS

CALCULATE, BY THE USE OF A FORMULA, THE PRODUCTION ESTIMATION FOR A TEREX CRAWLER-TRACTOR.

Trips per hour and payloads per hour govern the production of earthmoving equipment. The cycle time determines the number of trips per hour. It is evident that the supervisor will want to get as many trips per hour as possible. To do this the cycle time must be kept at a minimum. Production estimation of crawler-tractors involves factors such as the cycle time, the efficiency factor, and the amount of material that the machine is capable of moving per trip.

Formula. Production output (bank cu yd/hr) is computed using the formula

$$O = \frac{Q \times F \times 50 \times E}{C}$$

O = output per hour
Q = capacity of equipment
F = soil conversion factor
50 = min per hour (see Work Unit 2-12)
E = equipment efficiency factor
C = cycle time (min)

Example. A terex 82-30M is dozing common earth (loam). Assuming that the power requirements and limitations allow the machine to dig and carry material forward in intermediate and return at high reverse, what is the bank cubic yards production capacity of the dozer with a 150 ft pushing distance? For cycle time formula, please refer to Work Unit 2-7.

Q = 7.9 cu yd (loose) (fig 2-1)
E = .83 (para 2-12)
Intermediate forward = 3.8 mph (fig 2-2)
High reverse = 8.3 mph (fig 2-2)
F = 1.25 (fig 2-12)

Compute output = $\frac{Q \times F \times 50 \times E}{C} = \frac{7.9 \times 1.25 \times 50 \times .83}{.64} = 409.8$

Banked cubic yards per hour = 476.5

Dozer efficiency performance. To determine the efficiency of a dozer, it is necessary to look for certain items when observing the operation of the dozer and its operator. The following items might be useful as aids in helping you to estimate the performance of your operators and equipment:

Loading. In the loading operation, are your operators obtaining heaped loads? Is the backup tractor engine maintaining full rpm's, yet working fully? Are loads dozed in slots where possible?

Traveling. Is approximately 1.5 mph hauling speed being maintained? Is the backup speed being made in the highest gear possible? Are the maximum haul distances less than 300 feet? Where possible, are blade-to-blade and downhill dozing being used?

Spreading. Is time being wasted after the spread is made? Is the fill material being feathered out at the end of the spreading day? Is the fill material being spread in layers of proper thichness?

Mechanical check. Are all adjustments to the power unit being made? Are tracks properly adjusted? Are the dozer blades in good condition?

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. List the two factors that govern the production of earthmoving equipment.

   a. ____________________

   b. ____________________

2. Calculate, using the problem given below and the formula given in the text, the production estimation for a TEREX crawler-tractor.

   > A terex 82-30M is dozing clay. The power requirements and limitations allow the machine to dig and carry material forward in intermediate and return in high reverse. What is the bank cubic yards production capacity of the dozer with a 100 ft pushing distance?

   ____

   ____

3. List four items that may be useful as aids for estimating the performance of your operators and equipment.

   a. ____________________

   b. ____________________

   c. ____________________

   d. ____________________

Section IV. TRACTOR/SCRAPER APPLICATIONS

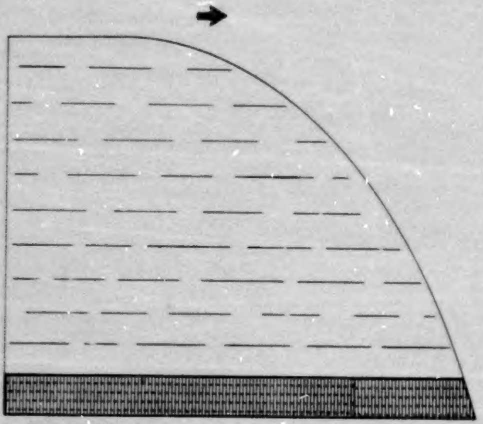
Work Unit 2-19. LOADING

LIST THREE METHODS OF LOADING USED IN TRACTOR/SCRAPER OPERATIONS.

Loading should be done in minimum time without excessive stress on tractor or scraper. Normally, heaped loads are best. In some types of soil, the last 2 or 3 yards of a heaped load require much time to load, and extra trips with smaller loads are justified. When loading wet sticky material where traction is bad, you should obtain good results by maintaining a thin cut and keeping the apron as low as possible to minimize material build up in front of the bowl. When planning for loading operations, you should consider the methods described below.

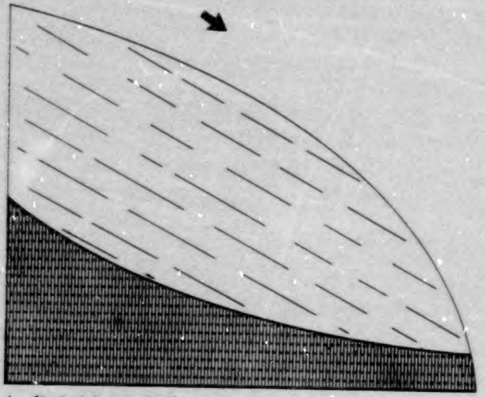
Making cuts. Constant effort is required to keep the cut level and free of holes, boulders, and high spots. Cutting and gouging by operators result in uneven cuts. Maintaining a moderate crown will permit the scraper to work nearer to the side of the cut without sliding away from it. At times, raising and lowering the blade will help to increase the load and will enable the pusher dozer, if used, to build up higher speeds. The variation from the high point to the low point of the cut should not be more than 4 inches. Cuts should be planned to provide adequate and natural drainage.

Downhill loading (fig 2-21). Downhill loading uses the forces of gravity acting on the tractor scraper to obtain greater loads in less time. The added force of gravity is 20 lb per gross ton of weight per 1% of downhill grade. Likewise this will have the same adverse effect if the hauling unit is traveling against the grade. This downhill pull will add more material per load, and the added material will in turn add to the gravitational force.



1. Wrong method does not establish down grade.

RIGHT



1. Start at top, work cut towards fill.
2. Work out in layers from back to front.
3. Adds more weight to tractor for loading

Fig 2-21. Downhill loading.

Straddle loading (fig 2-22). When it is necessary to load on level terrain, as in light cuts and stripping operations, straddle loading is used to increase the yardage hauled. Straddle loading may be used to improve performance when loading sticky material. After loading with number 1 scraper, number 2 scraper will make a parallel cut approximately 1/2 blade width away from the first cut, leaving an island of material between the two. The third scraper will straddle the island to obtain its material rapidly. This method gains yardage every third trip, because the center strip loads with less resistance than a full cut.

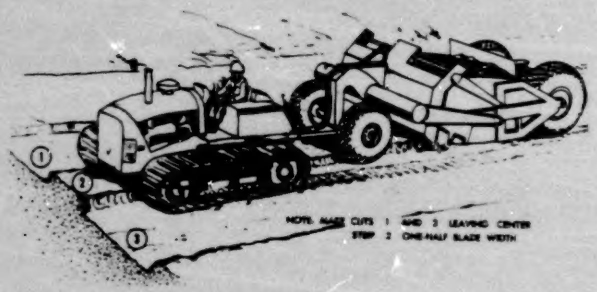

①
②
③
NOTE: MAKE CUTS 1 AND 3 LEAVING CENTER
STRIP 2 ONE-HALF BLADE WIDTH

Fig 2-22. Straddle loading.

Loading with a pusher dozer. A smooth loading operation is the fastest and most efficient way to obtain a maximum load every time. Teamwork operation of pusher and scrapers is essential to eliminate waiting time. Spacing of scrapers to enter the borrow pit area should be from 1.5- to 2.0- minute intervals. This will keep the pusher in continual operation and will avoid unnecessary scraper delays. The pusher operator is the spotter and guide for the hauling units. These units must be near the dozer when it is ready to push. The loading unit must not depend of the pusher to do all the work, nor should the scraper tractor wheels be spun in an effort to pull away from the pusher. To determine how many scrapers a pusher can handle, divide the scraper cycle time by the pusher cycle time. The average cycle time for a pusher is 1.5 to 2.5 minutes. The operator or the scraper should enter the loading area at the same speed as the one in which he returned from the fill area. If the approach and cut is level, this is a safe practice. The pusher operator should indicate the loading lane, and should be waiting about 45° off of the lane to be cut, allowing the scraper to come in fast and easy. After the scraper has been loaded, it should leave the cut as fast as possible, with its bowl slowly rising to spread the material that has piled up in front of it. This makes a smooth cut at the end of the fill area. It will allow additional scrapers to maintain speed when coming out of the fill area.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. List three methods of loading used in tractor/scraper operations.

   a. ______________________________

   b. ______________________________

   c. ______________________________

2. The forces of gravity acting on the tractor/scraper help obtain greater loads in (less - more) time.

3. Which type of loading may be used to improve performance when loading sticky material?

   ____

4. Spacing of scrapers to enter the borrow pit area should be from 1.5- to 2.0- minute intervals.

   a. True   b. False

Work Unit 2-20. HAULING

STATE WHY TURNS CAUSE A LOSS OF TIME IN HAULING OPERATIONS.

Travel time includes hauling time and return time. Here the power capabilities of the tractor become vital. Maximum efficiency in hauling is of the utmost importance because this operation consumes more time than any other.

Obtaining maximum efficiency. Wherever possible, adverse grades are eliminated to permit maximum travel at high speeds. Grade reduction (building long easy graded) are not always helpful because it may be more effective to climb a short steep slope in a lower gear than to climb a long easy grade in an intermediate gear. Well-maintained haul roads eliminate vibration, shock, and wear on the equipment and operators. They reduce equipment maintenance and increase operator efficiency. To withstand traffic, haul roads require a heavy compacted cover of good material. This will distribute the wheel loads over a wide area, increasing the bearing capacity of the haul road. The use of sprinklers to minimize dust conditions will permit higher hauling speeds. Roads that are moist will pack into hard, smooth surfaces. Sprinkling not only increases speed, but also reduces dust, which will sift into equipment parts and cause considerable wear and extra lube time. Less dust means better visibility and fewer accidents. Haul roads should be wide enough to permit two-way traffic. In the event the road is not wide enough to permit this, turnouts should be provided to enable slower moving vehicles to be passed by faster moving equipment. Space rigs efficiently; not too close and not too far apart. Make operators hustle when the distance between the rigs becomes too great, likewise make them run slower when the distance closes. When two rigs enter the fill area at the same time, have one dump at the end of the fill and one dump at the beginning. This will compensate for the spacing of the rigs. Have operators avoid lugging the engine. Downshift to a lower gear when it is apparent that speed cannot be maintained in the present gear. Even though the machine can take it, it is better to downshift and accelerate.

Plan travel cycles (fig 2-23). Because turns cause equipment to slow down, shift gears, and travel extra distances, they cause a loss of time in hauling operations. On the two types of cycles common to most earthmoving jobs, unnecessary turns are eliminated by cutting and spreading two ways; by using two cuts adjacent to a fill, or two fills adjacent to a common cut. An operator either works a cut from the center to a fill at both ends, or he works a cut at each end to fill the center. Instead of considering each area as a separate cut and a separate fill, a continuous cycle is established thereby eliminating two turns. On some jobs, particularly airfield construction, consecutive light cuts and light fills occur which are fairly evenly spaced and nearly balanced as to volume. Cycle time is reduced by traveling through the entire series, turning only at the ends.

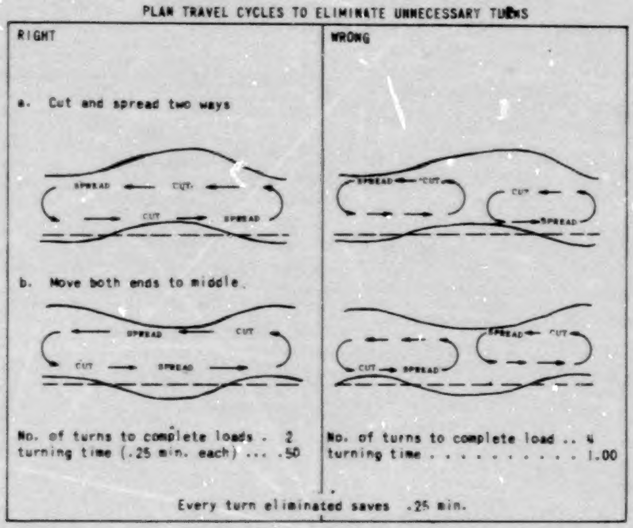

PLAN TRAVEL CYCLES TO ELIMINATE UNNECESSARY TURNS
RIGHT
WRONG
a. Cut and spread two ways
SPREAD
CUT
CUT
SPREAD
SPREAD
CUT
CUT
SPREAD
b. Move both ends to middle.
SPREAD
CUT
CUT
SPREAD
SPREAD
CUT
CUT
SPREAD
No. of turns to complete loads . 2
turning time (.25 min. each) ... .50
No. of turns to complete load .. 4
turning time 1.00
Every turn eliminated saves .25 min.

Fig 2-23. Cut and spread sequence.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. To withstand traffic, haul roads should have a ______________________________.

2. State why turns cause a loss of time in hauling operations.

____

3. How much time is saved by each turn that is eliminated?

a. .10 min	c. .50 min
b. .25 min	d. 1.00 min

Work Unit 2-21. CONSTRUCTING FILLS

LIST TWO METHODS OF CONSTRUCTING FILLS USING A SCRAPER.

Scrapers spread the soil while unloading and rarely require assistance from a dozer. The type of material controls the unloading and spreading of materials. Spreading is done at the highest speed possible. Unloading and rough grading are two methods of constructing fills.

Unloading. Normally, unloading is done in long thin layers to aid in compaction. Special techniques are necessary when spreading wet, sticky materials, such as raising and lowering the apron to lessen the amount of material in front of the bowl, and also pulling the tailgate forward and returning it a short distance. When unloading, plan scraper spreads. Spread the first load at the start of the fill. Travel with following loads over previous fill and make each following spread start at the end of the previous layer. Finish spreading one lane before starting a new lane so that compaction equipment can begin. Haphazard unloading of materials in the fill area delays construction time. In most cases a dozer will be needed to spread the material. Route the scrapers so that they will assist in the compaction of the material. Overlapping tire tracks aid in the compaction of the area and reduce the time needed for compaction by the rollers. Scrapers should unload at high speed without losing momentum. Dribbling the load at low speeds slows down the travel cycle. Always instruct your operators to maintain the fill slope by filling higher on the outside edges so that the scraper will not have the tendency to slide over or off the edges. When the scrapers are empty, get them off the fill area fast. Do not waste time. Plan the exit route from the fill area to avoid soft ground, trees, and other obstacles.

Rough grading. Finishing can be done with the scraper to a certain degree, particularly where low spots require material to be hauled in or where material is to be cut and used in the area. Grading is usually done at low speeds because high-speed spreading makes it more difficult to control the blade for a smooth finish. Grading is done by raising the apron to the full open position and by having the tailgate about three-quarters of the way forward and leaving it in that position. With these adjustments, it is only necessary to control the depth of the blade cut and its path. As the work nears completion, speed can be increased because the finish is smoother and less bouncing will occur.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. List two methods of constructing fills.

a. ____

b. ____

2. What is done in long thin layers to aid in compaction?

____

3. Describe how grading is done with a scraper.

____

Work Unit 2-22. PRODUCTION ESTIMATION FOR TRACTOR/SCRAPERS

CALCULATE, BY THE USE OF A FORMULA, THE PRODUCTION ESTIMATION FOR TRACTORS/SCRAPERS.

Estimation of the amount of material that a tractor/scraper can move is based on several factors. These factors include the length of haul and return distance, the amount and type of material that is hauled, grade and traction resistance, and speed of the hauling unit.

Formula. The production output for a scraper is computed using the same formula as the one used to compute the output for the crawler tractor: $O = \frac{Q \times F \times 45 \times E}{C}$

O = output per hour
Q = capacity of equipment
F = soil conversion factor
45 = min per hour (see Work Unit 2-12)
E = equipment efficiency factor
C = cycle time (min). For cycle time formula please refer to Work Unit 2-7.

Example. Having already covered rolling resistance, grade resistance, altitude effects, and traction limitations, you will only compute the amount of material that a scraper can move per hour. An MRS-I-100/105 SM-71 tractor/scraper combination hauls sand to a fill area a distance of 1,970 feet. Traveling to the fill area in 2d gear and returning from the fill area in 3d gear, what is the volume of material that can be moved per hour by this unit?

Q = 10.5 cu yd
F = 1.11 (fig 2-12)
45 = 45
E = .75 (Work Unit 2-12)
C = 4.7 min

$$O = \frac{10.5 \times 1.11 \times 45 \times .75}{4.7} = \frac{393.4}{4.7} = 83.7 \text{ cu yd per hour}$$

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. Calculate, using the formula, the production estimation of the tractor/scraper given in the following problem:

   An MRS-I-100/105 SM-71 tractor/scraper combination hauls sand to a fill area a distance of 2,500 feet. Traveling to the fill area in 2d gear and returning from the fill area in 3d gear, what is the volume of material that can be moved per hour by this unit during daylight hours?

Scraper capacity	Q = 10.5 cu yd loose
Total cycle time	C = 5.52
Soil conversion factor	F = 1.11
Efficiency factor	E = .75
Volume/hour	$O = \frac{Q \times F \times 45 \times E}{C} =$
	O =

Section V. ROAD GRADERS

Graders are primarily intended for shaping and finish work, and are designed accordingly. The small moldboard and comparatively lightweight attachments do not lend themselves to the roughing phases of construction usually handled by dozers. Limited dozer work may be done with the grader, provided the blade is not overloaded. The efficiency of a grader rests solely on the proficiency of the operator, since each job has a specific blade setting and speed for maximum production. Because of poor traction, motor grader efficiency may fall off considerably when operating in wet, muddy conditions.

Work Unit 2-23. CUTTING DITCHES

STATE THE PURPOSE FOR MARKING DITCHES DURING CUTTING OPERATIONS.

STATE THE CORRECT DEPTH EACH DITCHING CUT SHOULD BE MADE DURING CUTTING OPERATIONS.

In basic road construction operations, cutting ditches is done in the following basic sequences.

Marking ditches. Better grader control is maintained, and straighter ditches are cut, if an initial 3- to 4- inch deep marking cut at the outer edge of the bank slope is made on the first pass. The position of the blade is in line with the outer edge of the lead tire. The angle of the blade is approximately 25° to 30°.

Ditch cuts. Each ditching cut should be made as deep as possible without stalling or losing control of the grader. Normally, ditching cuts are made in 2d or 3d gear at full throttle. The blade is positioned so that the toe is in line with the center of the lead tire. Each successive cut is brought in from the edge of the bank slope so that the toe of the blade will be in line with the ditch bottom on the final cut.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. State the purpose for marking ditches during cutting operations.

____

2. State the correct depth each ditching cut should be made during cutting operations.

____

Work Unit 2-24. WINDROWS AND SHAPING

STATE WHICH GRADER OPERATION FORMS THE CROWN OF A ROAD.

When the blade is set at an angle, the pushed loads tend to drift off of the trailing edge of the moldboard. The rolling action caused by the curve of the moldboard assists this side action. As the blade is angled more sharply, the speed of this action is increased. Most road shaping and maintenance is done at a 25° to 30° angle. This angle is decreased for spreading and increased for ditching.

Moving windrows. When ditching cuts are made, windrows should be formed between the heel of the moldboard and the left rear tires. When the ditch is at the prescribed depth or the windrow reaches a height greater than the road clearance of the grader, the windrow must be moved or leveled off. The shoulder of the road is formed at this time. When operation produces more material than is required for the roadbed and the shoulders, excess material is moved into a windrow and hauled off. Windrows should not be piled in front of the rear tires because they will affect traction and accuracy.

Leveling windrows. This operation forms the crown of the road. All material spills off under the blade as the material is leveled. The forward and sideward movement of the loose material serves to distribute it effectively. If a windrow is left at the trailing edge of the grader blade it is picked up on the next pass. On the final pass a lighter cut is taken and the heel of the blade is raised enough to allow the spill to go under rather than around the blade to avoid leaving a windrow.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. When ditching cuts are made, where should windrows be formed?

____

2. State which grader operation forms the crown of the road.

____

Work Unit 2-25. BANK SLOPING

STATE WHY BANK SLOPING IS NECESSARY.

STATE THE PURPOSE OF THE CROWN OF A ROAD.

Bank sloping is necessary to prevent erosion of the bank slope. The eroded material from the slope could fill your ditching cut.

Sloping the bank. The most skilled operators are used to cut and trim the slopes of the fill or embankment section. The best operators should do the final excavation and close grading on the embankment. Extreme care should be taken to see that both the cut and fill slopes are started at the correct locations. Slopes should be trimmed as they are built and not left until the last operation. For example, a section of fill may be wider at the toe of the slope than specified for in the plans. By removing the excess at the beginning of the operation, only a comparatively small amount is handled. If the error is not corrected, the fill may reflect the error all the way to the top. Keep a constant check on slopes to see that proper ratios are being maintained.

Cleaning the ditch. After the bank has been sloped, it is necessary to clean out the material that has been cast into the ditch from the bank slope. This is done without any further cutting of the ditch itself. Usually only one pass is required to clean the ditch of all overflow material. This material is cast onto the shoulder of the roadway.

Reshaping the roadway. The next step in the formation of a road after the ditching and bank slope are brought to grade is shaping and finishing the shoulders and roadway.

Moving windrows and shoulder finishing. The windrow that is formed from the material cleaned out of the ditch is moved onto the road and at the same time the shoulder is finished into the desired slope. The minimum width of a shoulder is 4 ft on each side of the roadway. The minimum shoulder slope will be 3/4 inch per foot.

Spreading windrow on crown. The final operation is spreading onto the roadway the material that is brought from the ditch and shoulder, and bringing up the crown of the road. The purpose of putting a crown on the road is to remove surface water from the roadbed so that is does not penetrate the surface. The amount of transverse slope provided by crowning depends on the road surface. Smooth roads are crowned between 1/4- and 1/2-inch per foot. Gravel and rough roads require a crown of 1/2- to 3/4-inch per foot.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. State why bank sloping is necessary.

____

2. Which operators should be used to slope a bank?

____

3. What is the minimum width of a road shoulder?

a. 2 ft	c. 4 ft
b. 3 ft	d. 6 ft

4. State the purpose of the crown of a road.

____

Work Unit 2-26. SURFACE MAINTENANCE

LIST TWO METHODS USED TO MAINTAIN A SURFACE WITH A ROAD GRADER.

The surface or roads must be kept smooth at all times so that vehicle traffic can maintain speeds without undue wear and tear. Two methods used to maintain a surface with a road grader are scarifying and material distribution.

Scarifying. Potholes, ruts, and corrugation (washboarding) often occur on unpaved surfaces. When graders are used to correct corrugated roads, care must be taken to see that the condition is corrected rather than made worse. Deep cuts on a washboard surface will set up a blade chatter which emphasizes rather than corrects the corrugation. Scarifying scratches and stirs up the soil without turning it over to prepare it for the grader blade and is required if the surface is badly corrugated. When extremely hard surfaces or consolidated materials are encountered, it is recommended that alternate teeth be removed from the scarifier attachment, starting from the inside center tooth and working outboard. Never operate with less than six teeth. This will aid the passing of the teeth through the material and prevent damage to the scarifier or grader. Cut the surface to the bottom of the corrugation and reshape the road surface.

Material distribution. Ordinary leveling and surface maintenance are normally done by working the material across the road from one side to the other. To reduce loss of binder by traffic and wind erosion, caution must be used when disturbing the surface of dry roads. A satisfactory surface may be maintained in dry weather by working the material from the outside edges towards the center of the roads. Where binder is present and moisture content is appropriate, rough or badly pitted surfaces may be planed smooth by cutting action. The surface material is then spread over the smooth base. Reshape the surface by spreading the windrows evenly across the roadbed. Remember to always maintain the crown of a road to assist drainage.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. List two methods used to maintain a surface with a road grader.

   a. ____________________

   b. ____________________

2. Which is the minimum number of teeth that should be used when scarifying?

   a. 4
   b. 6
   c. 8
   d. 10

3. How are ordinary leveling and surface maintenance normally done?

   ____

Work Unit 2-27. ESTIMATNG WORK OUTPUT

ESTIMATE, BY THE USE OF A FORMULA, THE WORK OUTPUT OF A GRADER.

The time required to complete a grader operation depends on the number of passes necessary and the speed maintained on each pass. In turn, the speed depends on the operator's skill and the type of material handled.

Formula. A work output formula which may be used to prepare a preliminary estimate of the total time required to complete a grader operation is: total time (hours) = $\frac{PD}{SE}$

Number of passes. P = number of passes. This depends on the type of operation and must be estimated before construction begins.

Distance. D = distance, measured in miles. This is the distance traveled in each pass. This is also determined before the start of construction.

Speed. S = speed, expressed in miles per hour. It is the most difficult item to estimate correctly. As work progresses, conditions may require that speed be decreased or increased. The work output is figured for each operation which will be performed at different rates of speed. The sum of the values obtained in each part is the total time required for the operation. Care must be taken to use the correct number of passes for each speed used.

Efficiency. E = efficiency. Rarely can a road grader attain a full 60 minutes of work per hour. Efficiency varies depending upon the skill of the operator, maintenance requirements, and site conditions. The value 60% used in the example problem is average. It must be verified or adjusted on each job by observation and experience.

Example. Five miles of road are to be leveled and reshaped by a motorized grader. Six passes are estimated to be required to complete the job. The type of material to be worked permits passes 1 and 2 to be made in 2d gear (2.8 mph), passes 3 and 4 in 3d gear (3.4 mph), and passes 5 and 6 in 4th gear (5.6 mph). How much time is required to complete the project? The efficiency factor is 0.60.

Substituting in the formula: Total time $= \frac{2 \times 5}{2.8 \times 0.6} + \frac{2 \times 5}{3.4 \times 0.6} + \frac{2 \times 5}{5.6 \times 0.6} =$

$$= \frac{10}{1.68} + \frac{10}{2.04} + \frac{10}{3.36} = \frac{30}{7.08}$$

$$= 4.24 \text{ hours}$$

EXERCISE: Answer the following question and check your response against the one listed at the end of this study unit.

1. Estimate, by the use of the formula, the work output of the grader in the problem given below:

   Four miles of road are to be leveled and reshaped by a grader. Eight passes are estimated to be required to complete the job. The type material to be worked permits passes 1-4 to be made in 2d gear (2.8 mph), passes 5 and 6 in 3d gear (3.4 mph), and passes 7 and 8 in 4th gear (5.6 mph). How much time is required to complete the project? The efficiency factor is 0.70.

   Total time = ____________________ hours

Work Unit 2-28. TECHNIQUES FOR OBTAINING MAXIMUM EFFICIENCY

LIST TWO FACTORS THAT ARE IMPORTANT IN THE ELIMINATION OF UNNECESSARY PASSES.

Number of passes. Efficiency of grader work is in direct proportion to the number of passes made. Skill of the operator, coupled with planning, is of the utmost importance in the elimination of unnecessary passes. For example, if four passes will complete a job, every additional pass increases the time element for job completion by 25%.

Proper working speed. Operations are always performed in the highest speed possible consistent with conditions of the job site and skill of the operator. Operation in each gear range is done at full throttle. If less speed is desired, a lower gear range is used. Figure 2-24 lists suggested speed ranges for different operations.

OPERATION	SPEED (mph)
Maintenance	3-10
Spreading	3-6
Mixing	5-15
Ditching	2-3
Bank Sloping	2
Snow Removal	10-15
Finishing	3-5

Fig 2-24. Suggested speed range for various operations.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. List two factors that are important in the elimination of unnecessary passes.

   a. ____

   b. ____

2. In which speed should operations be performed?

   ____

3. Operation in each gear range is done at __________ throttle.

Section VI. CRANE-SHOVELS

Work Unit 2-29. TYPES OF CRANE-SHOVELS

LIST THE TWO TYPES OF CRANES USED IN THE MARINE CORPS.

The crane-shovel, with its different front-end attachments, is the most versatile piece of lifting and loading equipment available to engineer units. The basic crane-shovel unit consists of a lower travel assembly and an upper revolving frame. The lower travel assembly consists of a crawler or a truck assembly. The upper revolving frame consists of engine, controls, cable drums, and counter weights. Any one of the standard attachments may be mounted to the basic unit, depending on the work to be done. A crane-shovel is rated by the size of the material-handling bucket or by the load that can be lifted at a specified distance from the crane's center of rotation. The two types of cranes used in the Marine Corps are the crawler-mounted crane and truck-mounted cranes.

Crawler-mounted. The crawler travel assembly consists of the carbody (lower base) and the crawler frame. The crawler mounting is more stable than other types of mountings. It has a flotation advantage over other types of carriers and has excellent mobility on the job. For moving distances over one mile, it should be transported by trailer. Maximum grade capability is 30% on firm, dry material.

Truck-mounted. The truck mounting provides a less stable base, higher ground bearing pressures, and poor job mobility. The truck mounted crane does have greater mobility for getting from one job site to another. In lifting heavy loads, the attached outriggers are used to provide a more stable base from which to operate. Maximum grade capability is about 48% with firm underfoot conditions.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. List the two types of cranes used in the Marine Corps.

   a. ______________________________

   b. ______________________________

2. When moving a crawler-crane over a distance of one mile, how should it be transported?

   ____

3. What is the maximum grade capability of a truck-mounted crane?

   a. 25%
   b. 38%
   c. 48%
   d. 50%

4. The counterweights are not considered as part of the upper revolving frame.

   a. True
   b. False

Work Unit 2-30. SHOVEL FRONT

STATE WHY A SHOVEL FRONT IS THE MOST WIDELY USED TYPE OF EXCAVATING EQUIPMENT.

Shovels are best suited for general excavation against a high working face. They are the most widely used type of excavating equipment because they can dig harder materials, although material such as rock must be first broken with explosives. Proper alinement of the boom angle aids in maintaining a grade. A low boom is used for descending grades and a high boom for ascending grades. A high boom is best for hard digging because the radius from the center pin to the dipper is less and this makes the counterweight more effective. The shovel's direction of travel should be toward the working face to gain greater stability of the tracks. The drive spockets on crawler-mounted cranes should be away from the working face (to the rear) to avoid damage by the shovel dipper or dislodged boulders.

Digging. A shovel digs a bank of dirt or broken rock. Practical applications are digging in a clay bank or gravel pit, digging cuts for road construction, or any other job where there is a good bank or face against which the shovel can work. Two methods are used. First, there is the sidehill bench method. In this procedure, the shovel starts on the top portion of the hill and takes out a lift approximately at optimum depth and wide enough for efficient operation. At the end of this pass, the shovel takes out the parallel lift. The shovel then moves down the hill and takes out the next lift. The other method is the subsurface circular pit method, carried out by first ramping down to maximum optimum cutting depth and then working outboard in a circle. When the first circular bench is wide enough, the next is started. The pit is then extended in area and depth until the desired amount of material is obtained. The shovel also digs below grade to make shallow ditches or berms. Caution must be taken here so that the shovel does not undermine the ground and cause the walls to cave in and possibly overturn the machine. Other specific applications of the shovel are trimming and dressing slopes and banks.

Dumping. After the dipper is filled, the material is dumped into hauling units at or above shovel level. Dumping onto spoil banks is often done in stripping overburden. On hillside or mountainside road construction material is dumped by the side casting method. In sand or gravel pits, material may be dumped onto a belt conveyor or a grizzly.

Limitations. A shovel is used under the following general conditions. The excavation must be large enough to provide sufficient working area for the shovel and hauling equipment. The shovel must be able to dump at or above working grade level. The nature of the excavation must require a sufficient depth of cut to use the shovel at its full capacity.

Obtaining maximum efficiency. The shovel should be kept as level as practicable. Only material that is well broken up and rocks and boulders that will pass through the dipper are handled. At the start of digging, the bucket should be at crawler level, 2 or 3 feet in front of the crawlers. Digging too far beyond the boom sheaves is never practical, because the shovel's power diminishes rapidly as the dipper stick is extended beyond an imaginary line plumbed from the boom point sheaves to the ground. Best results will be obtained if the shovel is moved up often and kept close to the working face. The proper digging sequence after each move up is to start at the center of the face and make a cut, then make alternate cuts to each side of the center cut, keeping the face even. The dipper should be filled by straight forward passes against a working face. If one pass does not fill the dipper, the output can be increased by making a second pass before swinging and dumping. For example, a full shovel cycle with one pass takes 30 seconds and the dipper is six-tenths full. A second pass requires an additional 6 seconds and the dipper is nine-tenths full. Thus the capacity is increased 50% while the time cycle is increased 20% and the total output is increased by 25%. Swing time is a major part of the shovel cycle. Cutting a 30° arc from the swing-out and return increases shovel production approximately 15%. If the operators and drivers spot and load on 180° swing when the job could be planned for a 90° swing, nearly 1/3 of the possible production is lost. Experienced operators combine swing and dump to save time. Large excavators are better than small ones for digging in deeper cuts and harder materials. In operations presenting difficulty in getting full loads and requiring frequent moves, small machines frequently dig a greater output per hour.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. State why a shovel front is the most widely used type of excavating equipment.

   ____

2. What are the two methods used in shovel front operations?

   a. ____

   b. ____

3. The shovel must be able to dump at or above ____________________

4. What types of materials should you pick up with a shovel?

   ____

Work Unit 2-31. CLAMSHELL

STATE WHEN A CLAMSHELL IS BEST USED.

The clamshell digs or spot-dumps below, at, or above the level of the machine. It can handle or place material at a higher or lower level than either the shovel or dragline. A clamshell is best used when controlled excavation is required, such as culvert trenches or footings. It is also good at working hoppers in gravel pits.

Digging. The clamshell may be used to dig straight down, as in digging foundations, footings, pier holes, trenches, and basements. The clamshell's ability to dig vertically enables it to be used in trenches which are sheathed and have crisscross bracing. Clamshells are also used for digging roadside ditches and berms. In hard material, teeth are attached to the bucket jaws to facilitate digging and are removed for handling loose material in hopper work.

Dumping. Hoist and swing to dump position are done in one motion. The boom is never raised more than 60° in order to prevent the bucket from contacting the boom sheaves. The tagline is used to keep the bucket from twisting and turning and fouling the cables. For obtaining maximum accuracy in dumping, the clamshell is the perfect tool. It is used when dumping high above the ground level is required, and is especially useful for loading from stockpiles and dumping into hoppers, plant bins, and conveyors.

Limitations. The following general conditions control the use of the clamshell. The material being dug must be relatively soft or loose. The digging should be in the vertical range, below, at, or above ground level, requiring little or no lateral movement of the bucket.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. State when a clamshell is best used.

____

2. Hoist and swing to dump position are done in one motion.

a. True b. False

Work Unit 2-32. DRAGLINE

STATE FOR WHICH TYPE OF OPERATION A DRAGLINE IS GENERALLY USED.

Draglines are attached to crane booms and are generally used for operations where extended reach is an important factor; for example, in excavating irrigation ditches and drainage canals, in strip mining, and in gravel production. They are of extreme value where the shaping of steep bank slopes cannot be accomplished by either a dozer or grader.

Digging. The basic machine remains on firm ground and is capable of digging below its own level, backing away from the excavation as the material is removed. It is unexcelled for overcasting and is used extensively because of its large capacity and area coverage. When digging, keep the boom angle at 26° to 35° and try to drop the bucket in an area about 15° on either side of an imaginary line extending downward from the boom tip. Be sure that the bucket is not too large for the crane. The size of the bucket is determined by the weight of the material being handled, length of the boom, and engine power. Check the dragline capacity chart which is usually with the crane. DO NOT use the crane lifting capacity chart to determine the bucket size. Be sure that the operator removes the material in fairly horizontal layers. When excavating a ditch, take out the sides first then the center. This will keep the ditch from narrowing. Avoid piling the material in front of the machine so that the drag cable will not be pulled through it.

Dumping. The dragline disposes of material by side casting onto spoil banks, which makes it ideal for building levees or dikes. When loading into hauling units, it is advisable to use your most experienced operators. The exact spotting and dumping is a difficult task that requires a skillful operator.

Limitations. The dragline is best suited where the material to be dug is soft and loose. It is used where it is necessary to dig at or below ground level. Draglines do not dump as accurately as shovels or other excavators, so more time for dumping is needed when dumping into hauling units or hoppers. They are better suited for side casting and stockpiling. It should be noted that when the bucket is thrown beyond the end of the boom some control is lost. Boom angles of less than 35° from the horizontal are seldom advisable for dragline work.

Obtaining maximum efficiency. To obtain maximum efficiency at all times, there are several points to remember. When digging, keep the boom angle between 26° and 35°, dropping the bucket in an area 15° on either side of the boom point. Keep the bucket teeth sharp and have extra teeth on hand for replacements. Keep the machine as level as possible, and when working on soft ground, use timber mats for a solid footing. When swinging, the bucket is hoisted and swung to the dump point. These steps should be kept to a minimum. The return swing starts immediately after dumping and is carried through to the throw. The bucket is lowered during the throw.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. State for which type of operation a dragline is generally used.

____

2. During which phase of road construction can a dragline be used when a dozer or grader cannot?

a. Subsurface grade
b. Putting a crown on the road
c. Shaping of steep bank slopes
d. Edging

3. State the procedure for excavating a ditch.

____

4. When digging, at what angle should you keep the boom?

____

Work Unit 2-33. BACKHOE

STATE THE PRIMARY USE OF A BACKHOE.

The backhoe has some of the characteristics of both the shovel and the dragline. Its primary use is in digging below ground level. It will dig harder material than the clamshell or dragline because the weight of the boom itself is used to force the dipper into the material. The backhoe dipper is controlled more accurately than is the dragline bucket, therefore it is suited for close-limit work.

Digging. The backhoe is used to dig trenches, footings, and basements. It excels in this type of work because it digs straight vertical sidewalls, cuts a level floor, trims corners neatly and squarely, works from the top on dry safe ground, and reduces hand trim work to a minimum. When trenching, the backhoe is alined with the centerline of the ditch to be cut. After the specified depth is established, the backhoe is moved away from the cut to a distance that will enable the dipper to cut and drag the material out from the toe of the ditch. For basement-type excavations, the procedures may vary with the shape of the excavation, restrictions caused by the surrounding buildings, or a special requirement for disposing of the spoil. The starting sequence should be planned so that the machine works itself out of the excavation.

Dumping. The backhoe disposes of material by either dumping into haul units or onto spoil banks. However, its dumping range is not far as that of a dragline because of the fixed dimensions of the boom and stick. Consequently, the dumping range must be kept relatively short.

Limitations. The backhoe is limited in digging depth by the length of the boom and stick, and due to the short boom, the disposal or dumping range must be kept short.

Estimating work output. Digging depth and clearance are important in production capacity, but wide variations in operating conditions make any general table impractical. Cutting width rather than bucket capacity is usually the prime consideration. The output of this piece of equipment is difficult to estimate, and any estimation must be made by observing the time cycle over a period of time so that an estimated hourly output can be determined. The output of a backhoe is about 2/3 that of a shovel under the same soil conditions.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. State the primary use of a backhoe.

____

2. What is a disadvantage of the dumping capabilities of a backhoe?

   a. Fixed dimensions of the boom and stick and short dumping range
   b. Doesn't revolve far enough
   c. Cannot lift the load high enough to deposit it into dump trucks

SUMMARY REVIEW

In the preceding work units, you learned the primary uses and efficiency factors of earthmoving equipment. You also learned methods that can be used to increase the production output of bulldozers. You learned methods of loading used in tractor/scraper operations. You also learned the uses and techniques for obtaining maximum efficiency of road graders. The basic fundamentals of wheeled and crawler cranes were described for you, along with the different attachments that can be used with them.

Answers to Study Unit #2 Exercises

Work Unit 2-1.

1. Because of lower bearing pressure
2. Short haul excavations
3. The type of work to be done

Work Unit 2-2.

1. When hauls are long enough to develop high average haul and return speed or when crawler-tractors would be harmful to road surfaces.
2. b. Quarries
3. A weight transfer device

Work Unit 2-3.

1. When operating in light and medium soils relatively free of roots, stumps, and boulders
2. Because it has a tendency to pile up in front of the apron, and will not pile up in the bowl.
3. Straight, curved, and three piece

Work Unit 2-4.

1. The basic purpose is to lift a load and place it in a new position.
2. c. 3
3. Hook, clamshell, dragline, backhoe, shovel front, pile driver
4. properly supervised.

Work Unit 2-5.

1. General construction and maintenance of roads and airfields
2. Heavy, wet areas
3. Scarifier

Work Unit 2-6.

1. Swell
2. 20 x .72 = 14.4 cu yd per load
3. 2160 x 20 = 43,200 lb per load

Work unit 2-7.

1. The time require to load, haul, dump and return.
2. fixed time.
3. Variable time (min to fill area) $= \frac{9{,}000}{8.8 \times 88} = 11.3$ min

   Variable time (min for return trip) $= \frac{10{,}500}{12.4 \times 88} = 9.6$ min

   Total time per cycle = 1.9 + 11.6 + 9.6 = 23.1 min

Work Unit 2-8.

1. c, Drawbar pull
2. The formula $R = \frac{Wr}{D} \times R = 1{,}911$ DBPP

Work Unit 2-9.

1. Each 1% of adverse grade consumes 20 lb of drawbar pull per short tone of gross weight. Each 1% of favorable grade decreases the drawbar pull required by 20 lb per short ton of gross weight.
2. The formula $P = \frac{Wbg}{D}$. P = 4,778 DBP

Work Unit 2-10.

1. 30,033 DBPP available in intermediate range.
   20,802 DBPP available in hi range.

Work Unit 2-11.

1. Traction is the frictional force that resists the wheels or tracks from slipping on a particular soil.
2. Useable lb pull = 4,582 DBPP

Work Unit 2-12.

1. a. 83% with the tractor working 50 min/hr
   b. 75% working 45 min/hr
2. Decrease

Work Unit 2-13.

1. Clearing an area of all trees, downed timber, rubbish, and material embedded in ground.
2. Grubbing consists of the uprooting and removal of roots and stumps.
3. Don't work too close together, as falling branches will endanger the equipment operators.

Work Unit 2-14.

1. The removal and disposal of objectional topsoils and sods.
2. Dozers
3. 12 inches

Work Unit 2-15.

1. Angle dozer
2. Downhill

Work Unit 2-16.

1. a. parallel
   b. diagonal
2. Diagonal

Work Unit 2-17.

1. a. Blade-to-blade
   b. Slot.
   c. Downhill.
2. 50%
3. Downhill

Work Unit 2-18.

1. a. Trips per hour
   b. Pay loads per hour
2. 732.54
3. a. Loading
   b. Traveling
   c. Spreading
   d. Mechanical check

Work Unit 2-19.

1. a. Downhill
   b. Straddle
   c. Loading with pusher dozer
2. less
3. Straddle loading
4. a. True

Work Unit 2-20.

1. heavy compacted cover of good material.
2. Because turns cause equipment to slow down, shift gears, and travel extra distances.
3. b.

Work Unit 2-21.

1. a. Unloading
   b. Rough grading
2. Unloading
3. Grading is done by raising the apron to full open and by having the tailgated about three-fourths of the way forward and leaving it in that position.

Work Unit 2-22.

1. 71.26

Work Unit 2-23.

1. Grader control, straighter ditches
2. As deep as possible without stalling or losing control of the grader

Work Unit 2-24.

1. Between the heel of the moldboard and the left rear tires
2. Leveling windrows

Work Unit 2-25.

1. To prevent immediate or excessive erosion
2. The most experienced operators
3. c. 4 ft
4. To remove surface water from the source of the road

Work Unit 2-26.

1. a. Scarifying
   b. Material distribution
2. b. 6
3. By working the material across the road from one side to the other

Work Unit 2-27.

1. Total time = 4.24 hrs.

Work Unit 2-28.

1. a. Skill of the operator
   b. Planning
2. Highest speed possible
3. full throttle.

Work Unit 2-29.

1. a. Crawler-mounted
   b. truck-mounted.
2. By trailer
3. c. 48%
4. b. False

Work Unit 2-30

1. Because it can dig harder materials.
2. a. Sidehill bench
   b. Subsurface circular pit
3. working grade level.
4. Material that is well broken up and rocks and boulders that will pass through the dipper.

Work Unit 2-31.

1. When controlled excavation is required.
2. a. True

Work Unit 2-32.

1. Where extended reach is an important factor, such as excavating ditches, canals and strip mining.
2. c. Shaping of steep bank slopes
3. Remove sides first, then the center.
4. 26° to 35°

Work Unit 2-33.

1. To dig below ground level
2. a. Fixed dimensions of the boom and stick and short dumping range

STUDY UNIT 3

THE CONSTRUCTION SITE

STUDY UNIT OBJECTIVE: UPON SUCCESSFUL COMPLETION OF THIS STUDY UNIT, YOU WILL BE ABLE TO LIST THE TYPE OF SURVEYS AND DRAINAGE SYSTEMS USED AT A CONSTRUCTION SITE. YOU WILL BE ABLE TO STATE THE PRIMARY USE OF CONSTRUCTION STAKES AND THE PROCEDURES FOR SOIL IDENTIFICATION. YOU WILL BE ABLE TO ORGANIZE A CONSTRUCTION PROJECT.

When roads or airfields are needed in a theater of operations, they should be ready for use as soon as possible. The need is usually critical, and the accomplishment of a mission often depends on the use of these facilities. It should be emphasized that in the effort to obtain such facilities in a minimum amount of time, good engineering is the best timesaver. This does not mean that exhaustive field investigations or elaborate plans are necessary. Adequate investigation of the site and careful study of the design details are essential for greatest economy in construction time and effort. In the preliminary reconnaissance, it is possible that a few hours in soil investigation will save days in construction. In order to meet the design standards of strength and stability and to minimize the need for removal of undersirable materials, all roads and airfields should be located on terrain possessing the best possible natural soil conditions. Unless the soil is self draining, long stretches of flat ground should be avoided because of the difficulty of providing adequate drainage. Because the need for constructing drainage structures should be minimized, subsurface water should be avoided whenever possible. Though it is possible to construct French drains and other structures that will remove some moisture, the maintenance of these routes becomes extensive and presents continuous problems. Before locating any route, the general geology of the area should be analyzed. The existence of rock of sizable quantities at a construction project will cause a large removal problem, slowing construction and increasing construction effort. Engineer troops are seldom equipped or have the skill for rockwork operations. Earthmoving operations are the largest single work item on any project involving the construction of routes of communications. Any step taken to reduce large volumes of earthwork will result in a large decrease of required work. This will increase job efficiency. If possible, all necessary earthwork should be balanced. When there is a need for both cutting and filling at various points along the project, the material excavated should be used to construct the required embankments, thus reducing the need for earth-handling. Balancing cannot be done where the excavated materials are not acceptable for use. After information about the site is collected and the type of construction is determined, such details as establishing grade lines, location of work areas for different equipment, the sequence of operations, procedures for compaction, and the thickness of the base course and surface course must be considered in order to select the best possible solution.

Work Unit 3-1. SOIL CLASSIFICATION TESTS

LIST THE THREE TESTS USED FOR SOIL CLASSIFICATION.

Some knowledge of the physical properties of soil is essential in solving many problems of design and construction associated with roads and airfields. Soil is composed principally of rocks that have been broken down through time. It also contains air and water, as well as organic matter from decomposed plants and animals. The engineering characteristics of soil vary greatly, depending on such physical properties as particle shape, size, density, and consistency. It is therefore desirable to define these properties as a basis for the classification of the many types of soils. Such a classification system permits the ready identification of similar soils. The properties which identify and classify soils are known as index properties. The tests which determine these properties are known as classification tests. This system is based upon the Airfield Classification System developed during World War II by Professor A. Casagrande of Harvard University. The system was modified slightly and became the Department of the Army Uniform Soil Classification System. In turn, this system was modified and adopted by the Corps of Engineers and the Bureau of Reclamation in January, 1952 under the name of Unified Soil Classification System.

Classification tests. Soils are made up of grains which range in diameter from fairly large pieces of detached rock to very small particles. Soils may be divided into several different groups on the basis of the size of the particles included in each group. It should be noted here that the terms particle and grain are used interchangeably and are taken to have the same meaning. The scale used in the Unified Soil CLassification System is indicated in figure 3-1. Coarse gravel particles are comparable in size to a lemon, an egg, or a walnut, while fine gravel is pea size. Sand particles range in size from that of rock salt, through table salt or granulated sugar, to powdered sugar. Below a No. 200 sieve, the particles (fines) are silt or clay, depending on their plasticity characteristics. Several methods may be employed to determine size of soil particles and their distribution in a soil mass. Included in these are the sieve analysis, the wet mechanical analysis, and the combined mechanical analysis.

UNIFIED SOIL CLASSIFICATION SYSTEM	U.S. standard sieve size	
	Passing	Retained on
Cobbles	----------	3-inch
Gravel	3-inch	No. 4
Sand	No. 4	No. 200
Fines	No. 200	-------
Organic material	No size boundary	

Fig 3-1. Soil groups based on grain size.

Sieve analysis (fig 3-2). Separation of the soil into its fractions may be done by shaking the loose dry material through a nest of sieves of increasing fineness as shown in figure 3-2. Sieves which are commonly used by the military engineer have square openings and are designated as 1-, 3/4-, and 1/4-inch sieves and U. S. standard Nos. 4, 10, 40, 60, 100, and 200 sieves. The size of the sieve is based on the number of openings per lineal inch of screen. A No. 4 sieve has 4 openings per lineal inch or 16 openings per square inch, and so on. The size of the grain of the material being tested is determined by whether it is retained on one screen or passed on to another.

Fig 3-2. Sieve analysis.

Wet mechanical analysis. The lower limit for the use of sieves is the No. 200 sieve. This sieve has a total of 40,000 openings per square inch. It is sometimes desirable to determine particle sizes below the No. 200 sieve. This may be determined by a process known as the wet mechanical analysis, which employs the principle of sedimentation. This means that grains of different sizes fall through a liquid at different velocities. This analysis is not a normal field test. It is not particularly important in military construction except that the percentage of particles finer than 0.02 mm has a direct bearing on the effect of frost action on a soil.

Combined mechanical analysis. The procedures which have been described above are frequently combined to give a more complete picture of grain size distribution. The procedure is known as combined mechanical analysis.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. List the three tests used for soil classification.

   a. ____________________
   b. ____________________
   c. ____________________

2. What are index properties?

   ____

Work Unit 3-2. SOIL PROPERTIES

LIST THE SIX PROPERTIES OF SOIL.

The effects of particle size, shape, and gradation are not the only soil properties of concern to engineers. An understanding of the way soils are affected by water is more important than any other single factor.

Plasticity. One of the most important characteristics of the behavior of soils is known as plasticity. Plasticity is the ability of soil to deform under pressure without crumbling or breaking. Clay soils normally are plastic over a wide range of moisture content. Coarse soils, such as clean sands and gravels, are nonplastic. The degree of plasticity a soil possesses can be used as a general index to its clay content. Sometimes the terms "fat" and "lean" are used to describe the amount of plasticity. A lean clay can be described as one that has only slight plastic qualities because it contains a large amount of silt and/or fine sand.

Cohesion. Another important characteristic of soil caused by the presence of water is cohesion. Soils that are plastic are also cohesive. That is, they possess some cohesion or resistance to deformation because of surface tension present in the water film. Thus, wet clay can be molded into various shapes without breaking and will retain these though wet. Gravels sands, and most silts are not cohesive; these are called cohesionless soils. Soils of this general class cannot be molded into permanent shapes and have very little or no strength when dry and unconfined. Some of these soils may be slightly cohesive when damp. This is attributed to the surface tension in the water film between the grains of the soil.

Moisture content. The moisture content of soil is an extremely important factor. Moisture content defined as the ratio, expressed as a percentage, between the weight of water which is contained in a soil mass and the weight of solids contained in the soil mass. Without the most favorable amount of water in a soil mass, compaction of the material becomes difficult. The soil will break or crumble and support no weight. The difference in soil without moisture content and that which has some moisture content can be readiy observed at a beach. The sand that is above the tide line is dry and is loose and will not sustain any weight distribution. The sand that is at or below the tide line is compact and will sustain trucks and even heavy equipment. During construction it may be necessary to add water, in the form of sprinkling, or let the soil dry out to obtain the desired amount of compaction necessary for the load-carrying capacity of the construction.

Shrinkage. Most plastic soils will undergo a considerable reduction in volume when the moisture content is reduced. The effect is most pronounced when the moisture content is reduced from that of complete saturation to a very dry condition. This reduction in volume is called shrinkage and is greatest in clays. Some of these soils show a volume change of 50% or more when passing from a saturated state to a dry state. Cohesionless soils, such as sands and gravels, show no change in volume when dried. In clay soils, the internal cohesive forces set up by drying account for the rocklike strength of a dried clay mass. Both silts and clay soils may be subject to shrinkage with disastrous results in some situations. For example, the uneven shrinkage of clay materials may deprive a concrete foundation or structure of the uniform support for which it is designed and severe cracking or failure will occur when loads are applied to the surface.

Swelling. If water is again added to a soil mass which has undergone shrinkage, but is still saturated, it will enter the voids of the soil mass from the outside and destroy the internal forces. Thus, a soil mass will swell from the absorption of water. This expansion may be very large and if confined, such as by a concrete foundation, may be sufficient to cause severe cracking and damage to the structure. If water is made available to the soil mass after the moisture content has dropped below the shrinkage limit, the mass will generally disintegrate along the surfaces. Destruction problems associated with swelling are usually solved by taking steps to prevent the excessive changes in moisture content, removing the soils which are subject to these conditions, or stabilizing the soil mass.

Bulking of sands. This is the increase in volume which may occur in moist sand when it is disturbed and replaced in a loose condition. When sand is used as a foundation or as a fill material, it should be flooded and vibrated to produce a dense structure before pavement is placed on it. Bulking of damp sands is the principal reason why, in modern construction practice, sands to be used in concrete mixtures are measured by weight rather than by volume.

EXERCISE: Answer the following question and check your responses against those listed at the end of this study unit.

1. List the six properties of soil.

a.________________________________
b.________________________________
c.________________________________
d.________________________________
e.________________________________
f.________________________________

Work Unit 3-3. GRAIN SIZE

MATCH THE FOUR SOIL GROUPS WITH THE CHARACTERISTIC USED TO IDENTIFY EACH.

Gravel. You are probably familiar with gravel. In soil terminology, any bulky mineral grain larger than 1/4 inch, is classified as gravel. It is made up of rocks of various sizes, as a rule worn smooth by water action. Next to solid bedrock, well-graded and compacted gravel with enough fine material to fill the voids is the most stable base. This material forms a natural foundation material for base and surface courses for roads and runways. It is the easiest material to drain and compact. It is not affected greatly by moisture or subject to frost action.

Sand. Mineral grains ranging in size from about .10mm (millimeter) to 2mm in diameter are classified as sand. (There are abcut 25 millimeters to an inch.) Well-graded angular (particle-shape) sand is a desirable foundation material, if it can be confined. It is relatively easy to compact, easy to drain, is little affected by moisture, and ordinarily is not affected by frost action. If sand is uniformly very fine, it approaches silt and has many undesirable characteristics. Confined sand makes an excellent subgrade, and for this reason works well under landing mats.

Fines. The fine-graded soils are not classified on the basis of grain size, but according to how easily they can be molded, (plasticity) and compressed (compressibility). Typical soils of this group are inorganic silts which include very fine sands, rock flours, and silty or fine clay with slight plasticity. Loose type soils usually fall in this group. Also included are inorganic clays such as gravelly clays, sandy clays, fat clays, and the gumbo-type clay of southern United States, which have good compressibility.

Organic. These soils are readily identified by color, odor, spongy feel, and frequently by their fibrous texture. Particles of leaves, grass, branches, and other fibrous vegetable matter are common components of these soils. Organic matter is frequently indicated by the presence of olive green and light brown to black colors. The existence of large amounts of organic matter may often be detected by a distinctive odor, that of decayed vegetation. No laboratory criteria are established for these soils. They have so many undersirable characteristics that when encountered, they are either removed as objectionable material, or filled over with a material that meets construction requirements. In most cases of road construction, especially in southern United States, low swampy areas containing this type of soil are filled in.

EXERCISE: Match the four soil groups listed in column 1 (1 through 4) with the characteristics listed in column 2 that would be used to identify each (a-e).

Column 1

Soil group

_______1. Organic

_______2. Sand

_______3. Gravel

_______4. Fines

Column 2

Characteristics

a. Grain size larger than 1/4 in.
b. Grain size from .10mm to 2mm
c. Fibrous texture
d. Plasticity and compressibility
e. Solid bedrock

Work Unit 3-4. CONSTRUCTION SURVEYS

LIST THE THREE DIFFERENT TYPES OF SURVEYS USED ON A CONSTRUCTION SITE.

Time and labor will normally be saved by repairing or improving existing routes of communication. Only if this is not possible, new construction is started. When this is the alternative, a construction survey is undertaken. This is the orderly process of obtaining data for various phases of construction work. It includes the reconnaissance survey, the preliminary survey, and the construction layout survey. The reconnaissance and preliminary surveys are used to determine the best locations. The remaining surveys are done after the location has been established. Upon completion of a thorough construction survey, the information is transferred to the field by means of construction stakes. These stakes are the guides and the references for earthwork construction. They must be marked so that the construction will conform to the planned line and grade of the project, and so that the information on the stakes will be properly understood by the construction crews.

Reconnaissance survey. This survey provides the basis for selection of feasible routes or sites and furnishes information for use on subsequent surveys. Reconnaissance surveys are classified as either area or specific. An area reconnaissance covers a wide range in the search for a possible site and its primarily made with maps and aerial photos. The specific reconnaissance survey involves viewing designated locations from the ground and the air. Existing topographic maps and aerial photos should be used in conjunction with the ground reconnaissance. During the ground reconnaissance, questionable soils and water table elevations should be checked. Stream depths and velocities should be measured. Marshes, grades, rock outcroppings, and any other things that may affect final location should be checked and noted. On airfield reconnaissance, runway centerlines should be established and a profile taken. A complete reconnaissance report contains comparisons, findings, and recommendations that are supported by maps, field notes, sketches, photographs, computed data, and any other information collected before and during the survey. If, on the basis of this information, location cannot be determined, it will be selected during the preliminary survey. This is primarily true in road location.

Preliminary survey. The preliminary survey includes the establishment of a tentative centerline, the plotting of certain terrain features, determination of a few critical elevations, and field classification of the soils encountered. The most likely route is staked out, and this centerline is located with whatever degree of accuracy required for the given situation. Prominent terrain features which serve to identify the proposed centerline, and terrain features which influence centerline locations such as swamps, rock outcroppings, or dense woods are plotted. Elevations of key points which determine grades are established and cross-section elevations sufficient in number for making earthwork estimations are determined. Usually a map showing the proposed centerline, elevations of key points or contours, significant topography, and typical cross sections is drawn to summarize the survey. Soil classification data can be placed at typical locations on the map. The care with which the preliminary survey is accomplished influences the extent of the final survey. It is the preliminary survey which supplies the data needed for the final location studies and decisions.

Construction layout survey. This is an instrument survey which provides alinement, grades, and locations to guide the construction operations. It includes the exact placement of the centerline, layout of curves, setting all remaining stakes such as slope or shoulder, staking out necessary structures, laying out culvert sites, and other work required in order that construction may begin. The surveyors should stay ahead of the construction activity in both time and distance to guarantee uninterrupted progress of the construction effort. Aiding and controlling construction activities is one of the primary functions of the construction surveyor. Surveys are a continuous operation that is carried on until construction is complete. Stakes will be buried, lost, or destroyed by equipment, and consequently will have to be replaced. In the combat zone, it is conceivable that roads and airfields will be constructed with a minimum amount of preplanning and construction control activity. However, for a deliberate project, such as those to be constructed in the United States, extensive surveys may be conducted. The quality and efficiency of construction is directly related to the number and extent of surveys and other preplanned activities.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. List the three different types of surveys used on a construction site.

a.____
b.____
c.____

2. When do surveys end?

a. When construction starts
b. When the job foreman is satisfied
c. When construction is complete

Work Unit 3-5. CONSTRUCTION STAKES

STATE THE PRIMARY USE OF CONSTRUCTION STAKES.

The primary purpose of construction stakes is to indicate the alinement of the project to the equipment operators and construction crews. Stakes are also used to prevent excess work by indicating the limits of cut and fill at right angles to the centerline of the project.

The types of stakes include centerline, slope, ditch, offset, reference, grade, intermediate stakes and temporary bench marks. Stakes on which information is written should be approximately 1" x 3" x 2'. Finished lumber should be used whenever possible. If this is not available, small trees that have been blazed on both sides and cut to length can be used. Finished grade stakes and bench marks are usually 2" x 2" x 12". The stakes are placed by a 3- to 5-man crew equipped with a transit, a level of some type, a 100-ft steel tape, a rod, and an ax. There should be a clearance of 6 feet on each side of the cut or fill. Construction stakes are marked and placed to conform to the planned line and grade of the proposed construction. A uniform system of marking must be adopted so that the information on the stakes will be properly interpreted by the construction crews. Construction stakes indicate, at various locations, the following information:

The station or location of any part of the construction in relation to the starting point.

The amount of cut and fill from the existing ground surface to the top of the subgrade for centerline stakes or shoulder grade for shoulder stakes.

The horizontal distance from the centerline to the stake location.

The elevation when the stake is used as a temporary bench mark.

The side slope ratio used on slope stakes.

A typical set of construction stakes consists of a centerline and two slope stakes. This is referred to as a three point. Point one is the centerline, and points two and three are the construction limits of the cut and fill at right angles to the centerline.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. What is the primary purpose of construction stakes?

____.

2. What does a typical set of construction stakes consist of?

____.

Work Unit 3-6. DRAINAGE

STATE THE METHODS USED TO DRAIN SURFACE WATER FROM ROADS AND AIRFIELDS.

NAME THE TYPE OF DRAIN USED TO ELIMINATE WATER IN THE SUBGRADE OR BASE COURSES OF A ROAD OR AIRFIELD.

STATE THE REASON WHY A GROUND RECONNAISSANCE IS DESIRABLE.

STATE THE PURPOSE OF TEMPORARY DRAINS.

Drainage is an important factor in planning and designing all construction work, and it remains important during the entire construction period. The serviceability of a road depends upon the adequacy of the drainage system. The washout of a culvert or a portion of the roadbed due to faulty drainage systems may close the road to traffic at a vital time. Flooding caused by inadequate drainage may lead to failure of road and airfield surfaces. The first construction work then on any project should be the establishment of a drainage system for the work to follow. You should be fully aware of the function of drainage, including adequate drainage during construction, and the proper methods of providing it. The importance of drainage cannot be overemphasized.

The drainage system must be designed to effectively remove all surface water from operating areas, to collect and dispose of surface water from adjoining areas, and to collect and remove excess ground water. Before a detailed design of a drainage system can be made, the rate of supply or quantity of water entering the system at critical points must be carefully estimated. It is desirable to know the annual amount of rainfall. Rainfall intensity is based on information and data supplied by weather stations in the area and will include tables showing intense short periods, precipitation in periods from 5 minutes to 24 hours and annual rainfall statistics. However, seasonal variations and information on typical intense rainstorms are more important from the viewpoint of the drainage problem. Failure to consider the intensity of a severe rainstorm is usually the cause of drainage problems and failures. Consideration must be given to proposed use of the construction. If it is to be used for only a short period of time, a detailed drainage system would be a waste of time, labor, and materials. If improvement or expansion of the operation is anticipated, after the original requirements are met, drainage should be designed so that future construction will not load ditches, culverts, and other drainage facilities. The availability of engineer resources is an important preliminary consideration. Heavy equipment, such as dozers, graders, scrapers, and power shovels is commonly used on drainage problems. Where unskilled labor is in large abundance, together with handtools, much work can be done by hand. Provisions must be made for the proper use of all available materials necessary for construction of culverts, ditch linings, drains, and retaining walls.

Types of drains. All drains can be classified as either surface or subsurface. Classification depends upon whether or not the water is on or below the surface of the ground at the point where it is collected for disposal. Surface drainage provides for the collection and removal of water from the surface of roads and airfields. This is important because water on the surface interferes with traffic, causes erosion, and if allowed to seep into the surface, will cause damage to the subgrade. Surface drains also intercept, collect, and remove surface water flowing toward construction surfaces from adjacent areas. Subsurface drainage is similar in some respects to surface drainage. Water is present under the surface due to seepage from surface water and other bodies of water. Surface water seeps down through openings, unsealed surfaces, or laterally along the top of impassable soil or rock layers. Ground water may pond above in rock layers to form a subsurface lake or perched water table. Subsurface drainage is provided to collect and remove any flow of ground water into the subgrade; to lower water tables; to drain water pockets or perched water tables; or for any combination of these purposes.

Surface drainage structures. Surface water is removed from roads and airfields by providing adequate crowns or transverse slopes. Drain systems must accommodate the water entering from adjacent areas. Natural and artificial means are used, usually in combination, to intercept, collect, and disperse this surface water. Natural elements include streams, rivers, dry runs, and ponding areas. Artificial facilities are open channels or ditches, culverts, drains, and the necessary auxiliary structures.

Subsurface drain. In most cases, the presence of excess water in the subgrade or base courses causes a reduction in the stability of pavement foundation and damage from frost action. The entry of water to the subgrades can be attributed to surface penetration, ground seepage, or capillary action. To insure serviceability of roads and airfields in areas where these conditions exist, some method of control must be used to collect and remove this excess water. The removal of subsurface water may be accomplished by a system of subsurface drain pipes (pipes consisting of porous, perforated material or pipes laid with open joints) placed in trenches and backfilled with a suitable layer of filter material. Another method is the use of ditches or channels to lower the water table and prevent seepage. The ability of the open ditch or channel to remove this water depends upon the nature of the subsurface soil, the location of the channel, and the availability of a free outlet. There are other special methods such as dry wells which are designed to drain a perched water table into a lower ground reservoir. Subsurface drains may be categorized according to their purpose as base, subgrade, or intercepting drainage.

Drainage reconnaissance. A ground reconnaissance is desirable because many conditions that affect drainage can be seen only by visiting the site. In many places, gullies and other drainage paths indicate effects of rainfall. Puddles, wet soggy earth, and aquatic plant growth indicate that, for a certain part of the year, the natural drainage is inadequate for construction work. Dry and cracked soil is a sign of loss of water through evaporation and indicates inadequate subsurface drainage. Adjacent streams should be studied to determine the possibility of floods and the drainage outfall elevation. Springs, quicksands, seepage from steep banks, and other indications of high-water tables should be observed. The type, density, and extent of surface cover should be noted since the presence or absence of vegetation greatly influences runoff characteristics of the area. Before any design can be undertaken, basic information and data must be obtained. The amount of information needed, of course, is based on the complexity of the design.

Temporary drains during construction. Proper consideration of drainage during the construction period will frequently eliminate costly initial delays and future failures caused by saturated subgrades. A careful consideration of the following items will aid in maintain- ing satisfactory drainage during the construction period.

Diversion and outfall ditches. Drainage to eliminate water which would interfere with construction operations includes excavating diversion ditches to concentrate all surface waters in natural channels and building outfall ditches to drain low or swampy spots. Such work is an initial operation and may be done at the same time as clearing and grubbing. Careful consideration should be given to the draining of all roads, equipment areas, borrow pits, and spoil areas.

Use of existing ditches and drainage features. Maximum use should be made of all existing drainage facilities and ditches. Where possible, grading operations should be made downhill, both for economical grading and to utilize natural drainage to the fullest extent. Backfilling of existing ditches and drainage channels should be scheduled so as to permit the longest possible use of these structures for temporary drains. Construction drainage plans should be coordinated with the layout and design of the final drainage facilities to insure maximum use of temporary drains in contruction of permanent facilities. A particular effort should be made to maintain well-drained subgrades and base courses to prevent water damage.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. State the methods used to drain surface water from roads and airfields.

____

2. Name the type of drain used to eliminate water in the subgrade or base courses of a road or airfield. ______________________

3. State the reason a ground reconnaissance is desirable.

____

4. State the purpose of temporary drains. ______________________

____

Work Unit 3-7. ORGANIZATION OF THE CONSTRUCTION PROJECT

STATE WHAT IS AFFECTED BY THE PROPER SELECTION OF A CONSTRUCTION CREW.

STATE THE PURPOSE OF A TRAFFIC CIRCULATION OVERLAY.

Selection of the equipment for the job is done during final planning. In selecting the equipment needed, job directive and reconnaissance reports are reviewed. All construction problems which might arise are anticipated so that the necessary steps to prevent these problems can be taken into consideration. It may be necessary to make a second reconnaissance to insure that these anticipated problems actually exist.

Selection of construction crews. A construction element consists of equipment and men organized as a team or as crews to carry out specific portions of the job. These crews are organized after weighing all factors related to the job. Proper crew selection has a great effect on the overall progress of construction projects. Improper crew selection could create delays in these operations that could further cause problems in the delivery of materials, and other services important to the project. Proper crew selection has an affect on the progress of construction operations. A man with little training, say in grader operations, may not be able to operate efficiently. On-the-job training, of course, slows down operations, at least temporarily. Unexpected illnesses, emergency leaves, and the like may leave you short on experienced personnel. The way you use your crews depends upon the situation. It is necessary that you form the crews using the skilled operators on those jobs which require speed, efficiency, and exactness. Untrained personnel can be utilized in many other areas which require very little skill, but they must be closely supervised.

Traffic circulation overlays. To insure that teams work effectively without getting in each others way, an anticipated flow of material and equipment can be plotted on an overlay. If this reveals that any part of the work will interfere with another part, it is necessary to change the flow of traffic to eliminate a bottleneck. It may be necessary to reroute the traffic or to reschedule a portion of the construction. The plotting of traffic circulation on an overlay may also indicate the need for secondary construction such as a hasty haul road. The overlay may be used to determine the location of material stock piles, equipment pools, rock crushers, and other construction equipment. It should be remembered that the basic principle governing secondary construction is that the time spent on such site improvements must reflect on the time gained on the primary construction.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. What effect could the improper selection of a construction crew have on a construction project?____________________________

2. What is the primary purpose of a traffic overlay?________________________

Work Unit 3-8. CONSTRUCTION TASKS

LIST THE TASKS NECESSARY TO BEGIN A CONSTRUCTION PROJECT.

After all information is gathered, a final plan is developed. This plan includes necessary changes in job directives; final drawings; estimates of personnel, materials, and equipment required; the construction schedule; and the sequence of construction tasks. The remainder of this study unit gives attention to selection of equipment for typical construction tasks.

Clearing. This operation includes the removal of brush and trees from the construction site. The best piece of equipment for this operation is a crawler-tractor, especially for heavy clearing and on steep slopes. In light clearing, wheeled dozers have proven very economical. The clearing should start at the point of disposal and fan outward so that trees and brush can be pushed over a cleared area. The heavier dozers and best operators are used to fell trees. The lighter dozers and the less skillful operators are used to remove the debris. This is a good spot to use those operators who are not yet skilled in using a dozer. Trees are felled and debris is pushed toward the point of disposal. In construction where the facilities will be used for a long period of time and may be expanded, the debris should be burned off. For construction in a military theater of operations this is not necessary. The debris should be removed far enough away so as not to interfere with construction operations or any future plans of enlarging the facilities. Clearing rates using dozers are discussed in study unit 2.

Stripping. Stripping consists of removing the organic material or overburden from the construction project. Where this material is to be moved a short distance, dozers represent the best choice of equipment. For long hauls, tractor/scraper combinations are best. In some cases, graders may be used for light stripping. It is best to strip by loading while traveling toward the point of disposal. The rate of stripping depends on the volume of material to be stripped, the distance it is to be moved, and the capacity of equipment selected to move it.

Ditching and channeling.

Ditching. A ditching operation consists of shaping open drainage ditches and cutting trenches for the placement of utilities and closed drainage systems. Graders and dozers are used to cut open ditches. Where a trench is to be used for a closed drain, the backhoe is a good choice. The ditching operation should start at the lowest elevation to insure proper drainage of the project during construction. In backfilling, care should be taken to see that the material placed in the ditches is compacted to the maximum density required.

Channeling. This operation consists of diverting from the construction site all streams which might overflow or flow into the construction area, improving natural drainage channels, and constructing intercepting ditches and dikes. Dozers, shovels, scrapers, draglines, and graders are used for this operation. The type selected depends entirely upon the site conditions.

Cutting and filling.

Cutting. Cutting is the excavation of excess or objectional material from the site. As far as possible, the cutting is planned and keyed in with the filling operation, so that these two operations can be balanced as close as possible. Usually this calls for the removal of earth and rock layers. Dozers can be used if the distance is short or if it is a sidehill cut. Scrapers are used when the amount of material is large and where the hauling distance to stockpiles or disposal areas is beyond the economical hauling distance for dozers. When possible, rock formations and other hard materials are broken first with explosives to ease loading. In consolidated materials, it may be necessary to use rippers before the materials can be excavated with scrapers or dozers.

Filling. This consists of filling an area with materials which can be compacted to maintain the correct grade or elevation. There are three basic types of fill materials: earth, rock, and consolidated materials (soil and rock particles partly cemented together as in hardpan or shale). The type of fill materials used will affect the type of compaction equipment selected. Careful planning is needed to maintain proper balance between cutting, filling, and compaction tasks. The fill material is spread in loads suited to the compaction equipment used in the fill area.

Compaction. Compaction is the firm packing together of a soil mass. The compacted soil should have only a slight change in moisture content. You should spread fill materials in layers thin enough to assure uniform density throughout the mass, while controlling the moisture content. Compaction of fill material can also be improved by blending several types of soils together. Obtaining the right moisture content, if the fill material does not have a sufficient amount, is accomplished by using water distributors or by flooding an area. If moisture content is too high, cultivators or rotary tillers can be used to remove it by continually turning the soil until the desired content is reached. Sheepsfoot and pneumatic-tire rollers are used to compact the subgrade base and the subgrade. The base course is compacted by smooth wheel rollers where the material is hard and has a limited amount of fines. Pneumatic tire rollers are used on the base course when the material is soft and tends to break down under the action of a steel wheeled roller.

Fine grading. Fine grading consists of shaping the foundation, ditching cut sections, and smoothing and crowning roadways. Motor graders, towed graders, drags, dozers, and scrapers are used for grading. Scrapers can grade to within 1 inch of finish, but graders must be used to obtain smooth finished surfaces. Finishing operations should closely follow compaction to furnish a crowned, tight, water-shedding surface, free of holes which prevent runoff. The material is graded from one side of the roadway or runway to the middle and back to the edge until the required line and grade are reached.

EXERCISE: Answer the following question and check your answers against those listed at the end of this study unit.

1. List the 6 tasks necessary to begin a construction project. (In any order)

a. ____

b. ____

c. ____

d. ____

e. ____

f. ____

SUMMARY REVIEW

In the preceding work units you have learned to identify the different types of surveys and drainage systems used at a construction site. You learned the primary use of construction stakes and the procedures for soil identification. You learned how to organize a construction crew and construction project.

Answers to Study Unit #3 Exercises

Work Unit 3-1.

1. a. Sieve analysis
   b. Wet mechanical analysis
   c. Combined mechanical analysis
2. The properties which identify and classify soils.

Work Unit 3-2.

1. (In any order)
   a. Plasticity
   b. Cohesion
   c. Moisture content
   d. Shrinkage
   e. Swelling
   f. Bulking of sands

Work Unit 3-3.

1. c. Fibrous texture
2. b. Grain size from .10mm to 2mm
3. a. Grain size larger than 1/4 in.
4. d. Plasticity and compressibility

Work Unit 3-4.

1. a. Reconnaissance
   b. Preliminary
   c. Construction layout
2. c. When construction is complete

Work Unit 3-5.

1. To indicate the alinement of the facility to the operators and construction crews and to prevent excess work by indicating the limits of cut and fill at right angles to the centerline of the project
2. A centerline and two slope stakes.

Work Unit 3-6.

1. Adequate crowns or transverse slopes
2. Subsurface drain
3. Because many conditions that affect drainage can only be seen by visiting the site.
4. To eliminate delays and future failures caused by saturated subgrades during construction.

Work Unit 3-7.

1. Delays in operations.
2. To eliminate bottlenecks

Work Unit 3-8.

1. a. Clearing
   b. Stripping
   c. Ditching and channeling
   d. Cutting and filling
   e. Compaction
   f. Fine grading

STUDY UNIT 4

THE MAINTENANCE SYSTEM

STUDY UNIT OBJECTIVE: UPON SUCCESSFUL COMPLETION OF THIS STUDY UNIT, YOU WILL BE ABLE TO LIST THE CATEGORIES AND ECHELONS OF MAINTENANCE. YOU WILL BE ABLE TO DESCRIBE MAINTENANCE SHOP ORGANIZATION AND LAYOUT.

Section I. MAINTENANCE SUPPORT

Work Unit 4-1. CATEGORIES OF MAINTENANCE

LIST THE THREE CATEGORIES OF MAINTENANCE.

LIST THE ECHELONS OF MAINTENANCE WITHIN EACH CATEGORY.

The successful accomplishment of engineer missions depends largely on preventive maintenance of assigned equipment. Maintenance is the action taken to retain material in, or restore equipment to, a serviceable condition. It includes inspection, testing, servicing, serviceability classification, replacement, repair, rebuilding, and reclamation of equipment. Many processes, procedures, and techniques are involved. As a whole, they provide a guide for complete and proper maintenance of engineer equipment, beginning at the using-unit level and extending through the depot level. Each element of maintenance is assigned to a specific organizational level that has the capability to handle it. The basic maintenance problem is the development of a balanced, flexible maintenance structure. Within this structure the amount of maintenance to be performed at the appropriate maintenance levels is established. For more information on the maintenance system, refer to MCI course 04.12, MIMMS.

The maintenance system established by the Marine Corps is based on three categories of maintenance: organizational, intermediate, and depot. These three categories contain five echelons of maintenance. The first and second echelons comprise organizational maintenance, the third and fourth echelons make up intermediate maintenance, and the fifth echelon is depot maintenance. The echelon where specific work is to be performed is determined by the tactical situation, nature of repairs, time available, the number and skill of personnel, and the availability of tools, test equipment, and repair parts. Each of the five echelons of maintenance defines the scope and capabilities of each maintenance organization or facility. Higher echelons of maintenance perform that category of maintenance assigned their organization. They also perform, within their capabilities, overflow maintenance, which is beyond the capability of supported units. The lower echelons of maintenance should not attempt to perform any repairs that are assigned to a higher echelon. Evidence of such attempts or of abuse of equipment, or preventive maintenance beyond a unit's capability should be reported to the proper commander for corrective action. Sound maintenance practices in each echelon can be achieved only if this course is followed.

Organizational Maintenance. This category of maintenance is the responsibility of the using organization. Its phases normally consist of inspecting, servicing, lubricating, adjusting, and replacing of parts, minor assemblies, and subassemblies not requiring highly technical skills. Organizational maintenance includes:

> First echelon. Maintenance which is performed by the user, wearer, or operator.
>
> Second echelon. Maintenance which is designed to be performed by specially trained personnel provided for that purpose in the using organization. Operators should assist unit mechanics in performing second echelon maintenance.

Intermediate maintenance. Intermediate maintenance is the category of maintenance authorized and performed by a designated maintenance activity in direct support of the using activity, or by higher echelon maintenance units supporting the direct support maintenance activity. It is normally limited to replacement of parts, subassemblies, and assemblies. Intermediate maintenance units support lower echelons by providing technical assistance, mobile repair crews, and repair parts when necessary. Intermediate maintenance includes:

> Third echelon. This is maintenance normally performed in direct support of using units and in some specifically authorized cases, by the using unit. Limitations within this echelon are imposed primarily by the tools, test equipment, and repair parts authorized.

Fourth echelon. This is maintenance performed in rear areas by a higher echelon ~~than the main~~tenance organizations directly supporting the using units. It requires more elaborate facilities and is limited only by the tools, test equipment, and repair parts authorized.

Depot maintenance. Depot maintenance facilities repair materials requiring major overhaul or complete rebuild of parts, subassemblies, or end item. They normally support the supply function by rebuilding and returning materials to stock on a scheduled basis. Fifth echelon and depot maintenance are the same.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. Define maintenance. ______________________________

2. List the three categories of maintenance.

   a. ______________________________
   b. ______________________________
   c. ______________________________

3. List the echelons of maintenance, within each category.

   a. ______________________________
   b. ______________________________
   c. ______________________________

Section II. MAINTENANCE SHOP ORGANIZATION

Work Unit 4-2. ORGANIZATION

STATE THE MAJOR OBJECTIVE IN ESTABLISHING A REPAIR SHOP ORGANIZATION.

The repair shop is organized and operated to accomplish the mission of maintaining engineer equipment or restoring it to a serviceable condition. It may vary from an extensive permanent structure with a shop for each repair function, to the temporary shelter having all functions under one roof. The size of the repair shop is limited by the tactical situation, nature of repair, time available, skills and number of personnel, and the availability of tools, repair parts, and test equipment. Regardless of the size, if the shop is to function smoothly and efficiently, it is necessary to establish a sound organization. The principles of organization and the responsibilities and practices are applicable to all types and sizes of shops.

Objective. The major objective in establishing a repair shop organization is to provide a basis by which management can most efficiently and effectively maintain equipment in a serviceable condition and restore unserviceable equipment to a serviceable condition. The shop organization establishes the relationship between units and guides the flow of supervisory effort.

Policies. For successful operation and a smooth running shop it is essential that:

Every function be specifically defined.

Overlapping responsibilities be eliminated.

Authority delegated be equal to the responsibility.

Responsibilities of supervision be clearly defined and understood.

Orders be issued through established channels.

Each man knows his job, to whom he reports, and who reports to him.

Supervision. The equipment officer is responsible for overall supervision of the repair shop. To supervise elements effectively, the shop organization defines the various operations, details responsibilities for each operation, and defines the responsibility and authority of supervisors. As the shop maintenance chief, you will be in charge of a particular phase of work important to the efficient functioning of an organization. You can assign others to certain duties in the many activities within the shop, but the responsibilities are yours. You are responsible for all of the men working for you, directly or indirectly, and for all of the work performed by them. In assigning duties, a man's experience, his specialty, and his ability to get a job done should be considered. It is good shop practice to have a mobile repair truck in readiness at all times. A smart maintenance chief will keep a good all-round mechanic available for this position at all times. Do not pass up opportunities for OJT. On field emergency repair trips, send along a helper who does not have too much knowledge about emergency repair work. He can assist in making repairs and gain valuable knowledge about his work. Maintenance repairs in a permanent shop are usually more specialized than field maintenance repairs and the finished product is more complete. It is good practice to assign personnel having skill in a certain field such as engines (gas or diesel), tracked vehicles, cranes, or electrical devices to repair the equipment with which they are familiar. In all jobs, use less experienced personnel as helpers. You will find that these helpers are soon capable of performing work on equipment. When time permits, you should use every opportunity to develop other skills in your men. Shop rules, regulations, and standing operating procedures (SOP's) should be written, published, and posted throughout the shop.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. State the major objective in establishing a repair shop organization. __________

____

2. The shop organization establishes the relationship between units and guides the flow of the ______________ effort.

3. Who is responsible for the overall supervision of the repair shop?

   a. Equipment chief
   b. Equipment officer
   c. Admin clerk
   d. Supply man

4. If a mobile repair truck is part of your shop structure, who should you put in charge of it? ______________________________________

Work Unit 4-3. RESPONSIBILITIES

MATCH EACH UNIT IN A MAINTENANCE SHOP WITH THE RESPONSIBILITIES OF THE UNIT.

A repair shop normally consists of an administrative unit, an inspection unit, a production unit, a supply unit, and the required number of repair units. The specific size of these sections depends upon the particular echelon of maintenance. A typical shop organization is shown in figure 4-1.

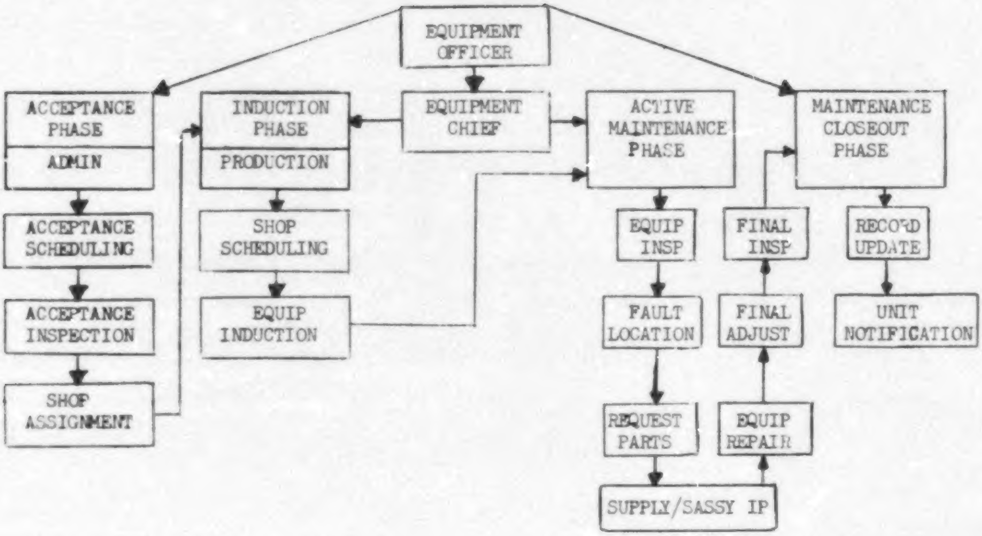

EQUIPMENT OFFICER
ACCEPTANCE PHASE
ADMIN
INDUCTION PHASE
PRODUCTION
EQUIPMENT CHIEF
ACTIVE MAINTENANCE PHASE
MAINTENANCE CLOSEOUT PHASE
ACCEPTANCE SCHEDULING
SHOP SCHEDULING
EQUIP INSP
FINAL INSP
RECORD UPDATE
ACCEPTANCE INSPECTION
EQUIP INDUCTION
FAULT LOCATION
FINAL ADJUST
UNIT NOTIFICATION
SHOP ASSIGNMENT
REQUEST PARTS
EQUIP REPAIR
SUPPLY/SASSY IP

Fig 4-1. Maintenance shop organization.

Administrative unit. The equipment/maintenance officer, assisted by the equipment/-maintenance chief and the required number of clerical personnel, make up the administrative unit. The equipment/maintenance officer is charged with the responsibility of operating and supervising the repair shop in the accomplishment of its mission. The duties of the administrative unit are to:

> Direct and administer shop activities and coordinate the work of all personnel, issue orders necessary for the proper operation and management of the shop, assign responsibility, and delegate authority to personnel to insure coordination and effective operation of the different units.
>
> Keep constantly informed of the shop's operation so that changing workloads can be met.
>
> Maintain close liaison with supported organizations so that their maintenance requirements may be preplanned and scheduled at a rate consistent with the shop's production capacity.
>
> Inspect incoming equipment records for proper completion, and maintain these records while the equipment is in the repair shop. The Equipment Repair Order (ERO) is also inspected for completeness and accuracy of information.

Inspection unit. The inspection unit is part of the acceptance phase (fig 4-1) and is composed of teams directly responsible to the equipment officer. They perform all of the inspection procedures utilized throughout the shop. Inspection personnel are not assigned production responsibilities since this might influence their decisions. The responsibilities of the inspection team are to:

> Inspect unserviceable equipment to determine the cost of repair and the echelon capable of this repair work. In addition, the inspection teams of the third and fourth echelon repair shops inspect all incoming unserviceable equipment for proper maintenance and records prior to the acceptance of the equipment for repair, determine the nature and extent of repairs needed to restore the equipment to serviceable condition, and make this information known to the production control and repair units.

Continually check all repair work to insure that approved practices are being followed and that all completed items meet the prescribed repair standards.

Insure that work performed complies with the provisions of technical manuals, modification instructions, and other directives.

Insure that all modifications have been performed on the equipment being inspected.

Inspect and give final approval to all repaired equipment before it is released and returned to the using unit.

Production control unit. The production control unit is the nerve center of the maintenance shop. It is through this unit that the equipment officer controls and administers the repair units. The four main functions of the control unit are forecasting, scheduling, routing and follow up. The unit is under the direct supervision of the equipment chief. The responsibilities of the production control unit are to:

Receive the equipment to be repaired, establish priorities for the work to be performed, maintain a balanced workload in the shop at all times, and return the completed work to stock or to the user.

Supervise all shop administration functions and records, and prepare and transmit all the required reports to the proper authorities.

Assemble data regarding the effectiveness of shop operations, analyze and evaluate it, and recommend to the equipment chief any indicated improvements.

Keep the equipment chief informed at all times of the status of operations and the extent of backlog.

Repair parts unit. Since the Marine Corps Integrated Maintenance Management System (MIMMS) requires that stockage of parts be minimal, parts requests are generated through the ERO Shopping List. Reconciliation with supply is necessary to ensure proper document assignment and status data is recorded. Close coordination with the shop chief is necessary to enable the scheduling of shop space and personnel to effect repairs as shopping lists are completed. The repair parts unit is also responsible for:

Maintaining liaison with the organizational supply office to insure that the authorized level of repair parts, tools, test equipment, and end items of equipment are on hand or due in.

Receiving parts and operating supplies, and providing proper storage and maintaining records of this material.

Coordinating with the production control unit the preplanning and procurement of supplies and repair parts required for anticipated or scheduled workloads.

Properly disposing of unserviceable parts and subassemblies.

Maintaining adequate tool rooms to conform with shop conditions and practices.

Initiating action for the cancellation of requisitions of items no longer required, and reporting items that have been erroneously issued.

Repair Unit. The repair unit has the responsibility of performing all repair operations in accordance with established standards and approved maintenance practices. The equipment chief has the direct supervision of this unit.

The unit is responsible for the accomplishment of the work listed on the Equipment Repair Order (ERO) and on the Work Sheet for Preventive Maintenance and Technical Inspection of Engineer Equipment. It is also responsible for repairing additional defects or work uncovered which may be required to complete the job.

The equipment chief may be assigned supervisory assistants as the scope and volume of work increases. The supervisory assistant insures that all personnel within his section comply with security and safety regulations and the maintenance practices and standards of the shop. He keeps the equipment chief informed of conditions within his unit, sees that a balanced workload is maintained, and makes sure that the number of personnel assigned to his unit is in direct proportion to his workload.

When the repair unit is subdivided into sections, the supervisor of each section is responsible for the work accomplished within his section and he sees that any instructions from the equipment chief are carried out. Each section is responsible for its own housekeeping within its assigned area and also for the proper care and usage of the tools and equipment used by personnel in that section.

Within each section the individual mechanic is responsible to his immediate supervisor for the compliance of instructions with the repair work assigned him. He requests additonal information from his supervisor when he does not understand work procedures. He is individually responsible for the proper use and care of tools and equipment, and for following established shop rules and regulations.

EXERCISE: Matching: In the group of items below (1-5) match the shop unit in column 1 with the appropriate responsibility in column 2. For each item select one letter (a, b, c, d, or e) indicating your choice, and place it before the unit. After the exercise, check your answers with those listed at the end of this study unit.

Column 1

Unit

1. _____ Administrative
2. _____ Inspection
3. _____ Production Control
4. _____ Repair parts
5. _____ Repair

Column 2

Responsibility

a. Establish priorities for work to be performed.
b. Maintain adequate tool rooms.
c. Accomplish the work listed on Equipment Repair Order.
d. Insure that all modifications have been performed.
e. Inspect incoming equipment record for completeness.

Work Unit 4-4. METHODS OF OPERATION

LIST THE TWO METHODS OF OPERATION IN A MAINTENANCE SHOP.

Repair shop operations vary in relation to the size of the unit, the mission, and the echelon of repair authorized. The methods and procedures of operations outlined herein are general and can be adapted to any shop with minor changes.

Methods of operation.

Job method. This involves the repair of each item of equipment as it becomes unserviceable. This is the type of operation that is most commonly used in organizational and field maintenance shops. The procedures for repairing equipment using this method are as follows:

The inspection team makes a thorough inspection of the unserviceable item of equipment to determine the nature and extent of repairs needed. They insure that the using unit has performed the required echelon of maintenance prior to turning the equipment in for repair. They also insure that all necessary records, forms, etc. accompany the equipment to the repair unit and that they are in order.

After receipt of the ERO, necessary parts to repair the item are determined. The ERO and the equipment are received by the repair unit for the action indicated on the order.

In the event that a major assembly is replaced, the information is recorded on NAVMC 696D (Motor Vehicle and Equipment Record Folder). The repaired item of equipment is then turned over to the inspection unit again for a final inspection. If the inspection team approves the equipment for release, it is returned to the user.

Production line method. The production line method of repair consists of the overhaul or complete rebuilding of the same kind of items or of items having some similarity among them. This is done by performing a scheduled set of operations on all items. This method is primarily used at the depot repair level, but may be done at force maintenance shops. The production line method depends on the accumulation of the same type of equipment having the same type deficiency to the point where it becomes economically and practically feasible to repair by this method. Repetitive operations are grouped and performed in a definite sequence at specific shop repair stations. The equipment to be repaired is moved through these stations in order, via conveyor belts or mobile racks. It is disassembled, inspected, and rebuilt in successive steps. Special jigs, racks, and fixtures are used whenever possible to reduce handling and accidents, and to decrease the amount of time spent on the actual repair of the item. Repair parts are stocked at every station so that they are readily accessible to the mechanic. The effectiveness of the production line method is realized when a large quantity of similar items is run through.

Procedures.

Preplanning and scheduling. The preplanning and scheduling of operations are based on the workload and availability of repair parts. To determine these factors, close liaison with unit supply and other echelons of maintenance must be maintained. Repair parts are controlled by the SASSY unit. The using unit has only a preexpended bin (expendable items such as nuts, bolts, filters, fan belts, etc). A list is made up by the using unit listing all of the items in the bin. If any other items are present, they must be listed on and backed up by an ERO. Beginning with the receipt of the equipment to be repaired, the work is planned so that it flows to and through the shop in a continuous and orderly fashion, with no delays and no backtracking. Information on the initial incoming inspection is used to predetermine just what parts are needed for repair. Prompt action is taken to have these parts available for repair of the item when the item is turned over to a repair section. Repair operations are broken down into sections, with each section responsible for certain types of repairs, such as the engine section responsible for repair of all gas and diesel engines. In the assignment of work, full advantage is taken of the skills of the mechanic. Repetition of operations tends to increase the skill and efficiency of your mechanics. Mechanics should be teamed where and whenever possible. A system of transferring equipment from one section to another should be established so that production control can plan and schedule operations with this in mind. Section chiefs should supervise all repair work in their section and enter all labor and materials expended for each job on the repair order before transferring the equipment to the next repair section.

Shop Practices. These should be covered by a shop SOP. Working areas and benches should be kept orderly and free from excess supplies, refuse, and unserviceable parts. Finished work and material destined for salvage or reclamation should be removed regularly to eliminate congestion in work areas. Work benches and tables should be arranged to permit maximum accessibility. Adequate tools and equipment should be made available to the mechanic. Every effort should be made to keep the mechanic supplied with work. Manuals, lubrication charts, and any other technical references must be made available to the mechanic and should be used by the personnel performing the repairs. Every effort should be made to improve the working conditions so that the highest production standards can be maintained.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. List the two methods of operation in a maintenance shop.

a. ______________________________

b. ______________________________

2. Which unit controls repair parts? ______________________

Section III. SHOP LAYOUT

Work Unit 4-5. ESTABLISHING MAINTENANCE AREAS

LIST THE TWO TYPES OF MAINTENANCE AREAS.

STATE WHICH OF THE THREE TYPES OF SERVICING AREAS IS THE SAFEST FOR SERVICE ON THE UNDERSIDE OF ENGINEER EQUIPMENT.

Repair shops range in size from the small-unit shops for maintenance of organic equipment to large installations capable of the complete overhaul and rebuild of unserviceable equipment. In engineer organizations of company size, the equipment officer operates his repair shop as a section of the organizational equipment pool. Larger organizations operate complete maintenance shops with a staff of military and civilian personnel. The size of the shop and the number of shop repair sections required is limited by the scope of the maintenance responsibilities, the shop equipment authorized, and the workload. In planning the shop layout and operations, consideration is given to the type of unit, its mission, and its responsibilities. The authorized echelon of maintenance establishes the scope of the shop . Shop equipment and tools are authorized for organizations on the basis of their maintenance responsibilities. Plans for shop layout and operation are based on the authorized echelon of maintenance, the anticipated type of work, the tactical situation, and the available personnel, shop tools, and equipment. The following factors should guide the location or relocation of equipment maintenance facilities or structures:

Convenience to supported unit.

Sufficient parking and maneuvering area for equipment overflow and heavy traffic concentration.

Protection from adverse conditions such as sand, dust, salt spray, chemical fumes, and wind.

Centralized grouping of facilities.

Temporary maintenance areas (fig 4-2). Location of a repair shop depends upon its mission, the tactical situation, the availability of wooded or readily camouflaged areas, the road net, and the location of using units.

Using units perform organizational maintenance with assigned personnel and organic tools and equipment, regardless of their location.

In forward areas of a combat zone, force and division using units have their own mobile shops and welding equipment. In addition to these facilities, all troops that are not in isolated areas are furnished with direct support engineer maintenance from general-purpose mobile shops provided for by third and fourth echelon maintenance units, or maintenance teams from these units may be assigned to them.

The equipment maintenance shop area usually is one of constant traffic concentration. For this reason, provisions are needed for definite zones within a shop area. Those zones should be designated for specific purposes that include: access, temporary parking, stand parking for longer periods of time while waiting for repairs to be done or to be resumed, dismantling stands, inspection stations, and test areas. If possible, roadways should conform to demands for 2-way traffic. Turnarounds should be provided for the largest piece of equipment that is supported.

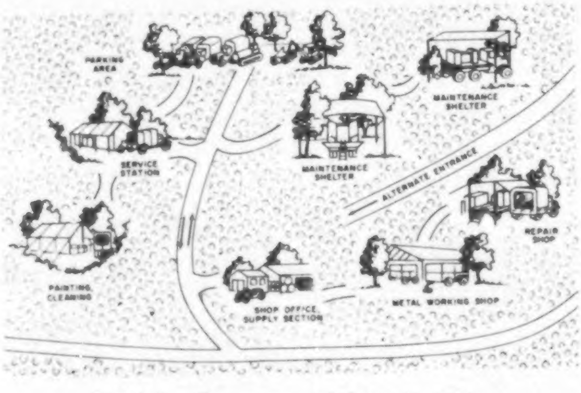


Fig 4-2. Temporary maintenance area.

Permanent maintenance area (fig 4-3). In CONUS, maintenance is normally performed in fixed locations or shops. Here again the facilities are governed by the mission of the particular unit and will vary in size and design to conform with the workload, category of maintenance performed, and type of equipment serviced. The number and sizes of entrances and exits relate directly to the equipment types to be supported and the workload. Dimensions and construction of doors or access spaces should permit safe passage of the largest equipment types to be serviced in the shop area. Because work in an unprotected, open area is not practical, the importance of suitable access should be emphasized. The size of the working areas should not be limited to the outside dimensions of the equipment being repaired. The size of the working area should allow room for movement of men, tools, equipment, material, carts, lines, hoses, and floor model chain hoists between and around the equipment. For this reason, boundary lines should clearly outline each working area. Where possible the outline of each space should be marked at the limit of a rectangular area, 3 feet from the outside dimension of the largest piece of equipment serviced in the shop space. Center aisles should be wide enough to permit equipment flow through the building and in and out of working areas. Concrete floors that are serviced by heavy-duty runways and protected by an effective drainage system are recommended where possible.

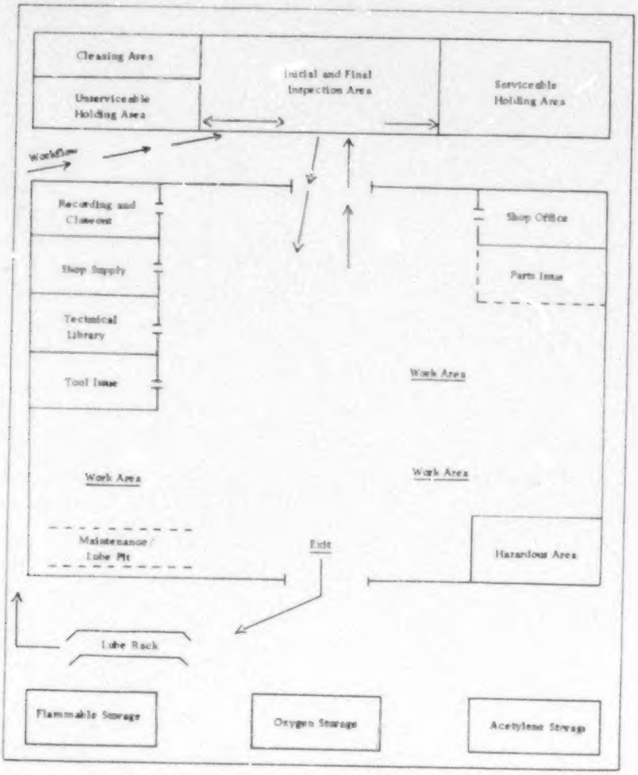

Cleaning Area
Unserviceable Holding Area
Initial and Final Inspection Area
Serviceable Holding Area
Workflow
Recording and Closeout
Shop Supply
Technical Library
Tool Issue
Shop Office
Parts Issue
Work Area
Work Area
Work Area
Maintenance/Lube Pit
Exit
Hazardous Area
Lube Rack
Flammable Storage
Oxygen Storage
Acetylene Storage

Fig 4-3. Permanent maintenance area.

Servicing areas. In selecting the maintenance facilities, either temporary or permanent, an adequate area for establishment of a fuel and lubrication area must be considered. This area must be close enough to the central maintenance area for easy access but far enough away so as not to become a potential fire hazard to the maintenance facilities. Servicing facilities consist of refueling equipment, lube racks, cleaning facilities, and lubrication dispensers, and should have a source of compressed air.

Grease pit. Access to the underside of vehicles and equipment is necessary for important maintenance and repair work. Construction of pits and ramps is necessary for the repair facility to properly perform its mission. The use of either pit or ramp depends to a degree on what type of equipment is being serviced. Since most heavy equipment is several tons or more in weight, a pit would be the safest and fastest method of installation. Pits should not be less than 4 or 5 feet deep, since personnel should not be required to work in a stooped or crouched position. The maximum distance between guard curbing should be no more than 42 inches. Design and construction of the pit will normally conform to the type of equipment being repaired or serviced. Construction of a typical grease pit is illustrated in figure 4-4.

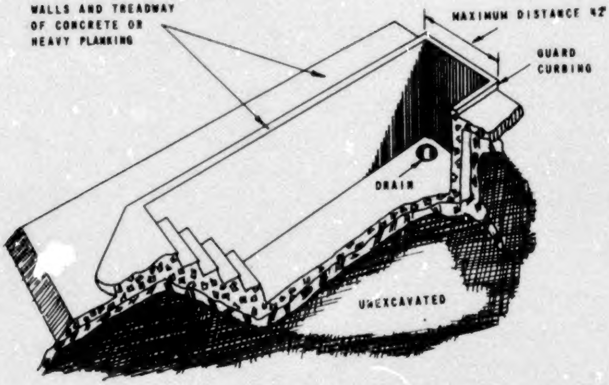

WALLS AND TREADWAY OF CONCRETE OR HEAVY PLANKING
MAXIMUM DISTANCE 42"
GUARD CURBING
DRAIN
UNEXCAVATED

Fig 4-4. Construction of grease pit.

Grease rack. Where drainage, soil, or other considerations prevent the construction of a pit, a grease rack can be installed (fig 4-5). This type of service facility should be used only with light equipment, since there is a danger of collapse when dozers or other heavier equipment are driven onto the rack. In the event that soil conditions will not support a grease pit, it may be necessary to construct an earth fill on the ground level, and build a combination rack and pit (fig 4-6). Dimensions are basically the same as the grease rack or pit. Only the ingenuity of the builder limits the type of construction.

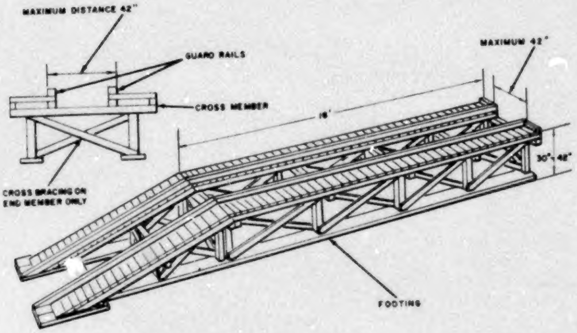

MAXIMUM DISTANCE 42"
GUARD RAILS
CROSS MEMBER
16'
MAXIMUM 42"
30"-42"
CROSS BRACING ON END MEMBER ONLY
FOOTING

Fig 4-5. Construction of a grease rack.

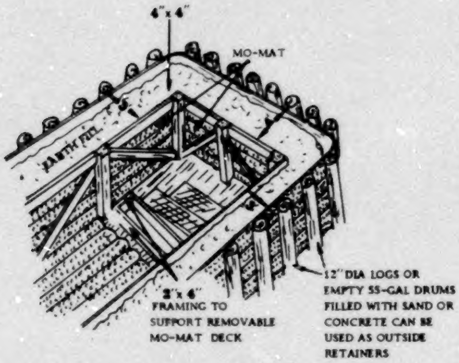


Fig 4-6. Construction of a rack/pit combination.

Fuel storage and dispensing area. In the field where permanent fuel storage tanks and disposing pumps are not available, it is necessary to draw fuel from drums. This is normally done with hand pumps. If the materials are available, elevated drum racks can be constructed and gravity flow can be used. All fuels and lubricants are stored with the bungs and vents positioned below the fuel level. This prevents water from collecting on top of the drums and preserves the bung gaskets by keeping them wet. Rubber-tired equipment should not be parked or stored in or near fuel storage areas because fuels and lubricants will decompose rubber. Three important considerations in refueling (aside from using the right fuel) are safety, cleanliness, and time. Cleanliness of fuels in today's modern internal-combustion engines is a prerequisite for efficient engine performance. Gasoline engines require clean fuel to prevent clogging and fouling of fuel lines and carburetor jets and passages. Diesel engines require clean fuel not only to run the engine, but it is also used to lubricate these moving parts. In this respect, all possible precautions to prevent the entrance of dirt and dust particles and the contamination of the fuel with water should be taken. From the standpoint of safety, there shall be no exception to these rules:

> Refueling any type of equipment with liquid fuel while the engine is running is prohibited.
>
> Smoking or the existence of open flames on or in the vicinity of the fueling/-storage area is prohibited.
>
> Standard safety cans shall be used whenever gasoline, diesel, or any volatile liquids are being transported to equipment in containers of 5 gallons or less. Fueling of any equipment in the maintenance shop is dangerous and should be prohibited.

If time is a limiting factor and it is more convenient to refuel on the job rather than secure a piece of equipment and send it back to the pool, it can be refueled on the job by a refueler. Keep in mind the safety factors and cleanliness of the fueling operation.

Repair stalls. Repair areas where the equipment and components are removed, disassembled, repaired, and reassembled or replaced are usually detemined by the mission and size of the unit and its workload. These stalls should be of sufficient area to permit ample parking space for equipment undergoing repairs and to allow working space for the mechanics. Each area should have a diptank for cleaning parts. These can be constructed from empty 55-gallon drums cut horizontally. Only approved cleaning solvents should be used. DO NOT USE GASOLINE. The repair stall should be equipped with a bench and bench vise, sufficient electrical outlets for the use of power handtools, a suitable storage space for handtools, and a source of compressed air. Each area should have a minimum of four safety floor stands and one 10-ton hydraulic floor jack. Other special tools and equipment, such as bench grinders, drill presses, and hydraulic arbor presses should be conveniently located so as to be available for use by all hands. Common hardware items can be deposited in centrally located "lazy susan" type circle bins or specially constructed wooden box bins. Repair stalls must be well lighted and ventilated. In the event that there is no exhaust evacuation system, flexible steel piping or rubber heater duct hose can be utilized for the exhaust fumes. If a shop truck is organic equipment, it should be located so that it is accessible to the mechanics. When size and ability of vehicle to maneuver make it necessary to perform repair functions outside the shop, facilities and temporary shelters are provided.

Office layout. In general, small shops require office space only for the equipment officer, the equipment chief, and the shop clerk. In a small shop, functions of supervision, production control, inspection, and management are frequently exercised by one or two persons. In larger shops, each of these functions may require the full-time efforts of one or more persons. Regardless of size, provision is made in the office layout for all of the functions of management, such as: receiving and inspecting all equipment coming to the shop for repair, preparing repair orders, supervising the shop activities, and maintaining the required records and reports. Repair jobs are assigned through the office and final release is made through the office after final inspection has been completed. Because this office makes initial and final contact with repair requirements, it is located at or near the entrance of the shop or equipment pool area.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. List the two types of maintenance areas.

   a. ____________________
   b. ____________________

2. State which of three types of servicing areas is the safest for service on the underside of engineer equipment. ____________________

Work Unit 4-6. SPECIAL TOOLS AND EQUIPMENT

STATE WHERE SPECIAL TOOLS AND EQUIPMENT SHOULD BE PLACED IN A MAINTENANCE SHOP.

In a maintenance shop set up for repairing all types of equipment, you will coordinate and supervise the work of gasoline and diesel engine mechanics. The layout of the shop and the placement of the equipment should receive considerable study. This is where experience in all types of repair jobs is valuable. You should know where the repair equipment is needed and where it is accessible to the men who will use it. Without proper care and forethought, considerable space will be wasted. In addition, much time may be lost in shifting equipment from one place to another. Where shop space is a factor, specific repair equipment is arranged in departments separated from the main shop areas or placed in smaller adjoining shops or rooms.

Special equipment. Power tools such as drill presses, arbor presses, and bench grinders commonly used in repairing equipment should be located at or near the workbenches in the main shop areas. The location of other power tools, such as hydraulic lifts and lathes depends on how often these tools are used in the shop. In placing power tools, secure the legs or base to a level surface and make sure that they will not move or bounce when in use. Before connecting stationary, electrically operated tools to power outlets, be sure that each one is positioned so that the starting and stopping switch is within easy reach. When the installation is completed, try the tools to insure that they are safe. Let your men operate them and consider any suggestion they may have for improvements. These double checks often reveal errors in an installation which may affect the efficiency as well as the safety of the maintenance shop as a whole. The master switch that controls all of the power in the shop area should be installed where it can be reached in an emergency. Mobile machine shops are provided to engineer field maintenance units and some engineer operational units. These mobile shops are completed units in which tools and equipment are provided for most of the machine operations required for maintenance work. If a mobile machine shop is not organic equipment, or if it must be supplemented with additional equipment, floor space for each machine and an adequate working area around it are required for the machinists and for the material being repaired or fabricated. Tool cabinets are provided for machine tools and attachments. Much of the work accomplished in the machine shop is of an exacting nature, and finished products are held to close tolerances. Adequate lighting is a must so that the worker may meet the high standard of quality that is demanded. A workbench with vise is required for filing, polishing, and other such jobs.

Welding equipment. Welding equipment used inside the shop area must be separated from the main shop area. Nonflammable screens or shields should be provided to eliminate fire hazards and injury to personnel. Welding stalls are enclosed to prevent glare and injurious rays of welding operations from interfering with other workmen. In cases where equipment cannot be moved to the welding shop, the welder must go to the equipment. Transportable screens are used to enclose the work and protect other nearby personnel. All precautions must be taken to protect unshielded eyes from glare and hot slag particles. Adequate ventilation of the welding shop is a must and should be provided.

Air compressor. Before deciding where to place the air compressor, consider the uses you have for it and where air outlets would be most convenient. The compressor will have to provide air for operating pneumatic power tools and for cleaning parts. By keeping compressor lines short, with minimum bends, you can prevent pressure drop at the air outlets. Short lines do not collect water as much as long lines do, and they are less likely to freeze in cold weather. If long lines are necessary and are used, install serveral condensation traps and drain them frequently. If the shop is a large one, it would be advisable to have more than one compressor.

Battery-charging equipment. This is definitely a "must have" operation for any maintenance facility, regardless of size. The battery room must be in a well-ventilated section of the shop and, if at all possible, it should be in a separate building. The fumes from a charging battery are poisonous and highly flammable. If possible, locate an exhaust fan in the area of the battery charger. The battery room should have running water and an adequate supply of a baking soda solution mixed and readily available for instant use. Protective clothing will be worn at all times, and smoking in the area is prohibited.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. State where special tools and equipment should be placed in a maintenance shop.

____

2. Why should stalls be used in a welding shop?

   a. So outsiders cannot see what you are doing
   b. So glare and injurious rays will not affect others
   c. So you will not be distracted while welding
   d. To block out sunlight

3. What advantage do short air compressor lines have over long ones?

____

4. Which of the following should be practiced in a battery charging room?

   a. Smoking in work area
   b. Work in a closed in area
   c. Charge batteries with caps on
   d. Wear protective clothing

Work Unit 4-7. HEAT, LIGHTING, AND VENTILATION

STATE WHICH FACTOR DETERMINES WHETHER OR NOT YOU HEAT YOUR SHOP.

STATE HOW TO REMOVE EXHAUST GASES FROM THE OVERHEAD OF A MAINTENANCE SHOP.

Heat, lighting, and ventilation for larger permanent maintenance shop facilities are included in plan specifications. However, installations of these facilities in the small or temporary shop will depend upon the individual in charge of the shop.

Heat. Whether or not you heat your shop depends upon the geographical location. Heaters should be arranged to provide warmth where it is most needed. Persons working at benches require more heat than men working in the main shop area for comparatively short periods. For this reason, heaters are placed in corners convenient to workbenches and away from shop doors.

Light. For proper lighting, most maintenance shops depend on lights arranged in the overhead of the main shop area, lights and windows near workbenches, and extension or drop lights which can be plugged into electrical outlets. When you are in charge of setting up a shop, make sure that enough outlets are provided for extension lights and electric power tools. Only the most elaborate shops have enough windows for efficient lighting.

Ventilation. Removing exhaust gases becomes a big problem in every maintenance shop. Large doors in the front and rear of the shop and windows at the work benches will normally supply all the fresh air needed, but even these are inadequate to remove excessive amounts of exhaust gases. These gases rise and are trapped in the shop overhead unless ventilating fans with roof openings are provided. Normally it is up to the supervisor of a temporary shop to provide his own method of ventilation. A piece of flexible steel or neoprene hose attached to the exhaust of a running engine and carried through an opening in the building will serve the purpose. Do not allow any unnecessary operation of engines inside the shop. When stationary gasoline or diesel engines are used to supply or produce power in the maintenance area, provide exhausts for them. Do not depend upon natural ventilation through shop doors or windows.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. State which factor determines whether or not you heat your shop.

2. State how to remove exhaust gases from the overhead of a maintenance shop.

SUMMARY REVIEW

In the preceding work units you have learned the categories of maintenance and the echelons of maintenance within each category. You have also learned how to organize and lay out temporary and permanent maintenance shops. You have learned the responsibilities for each unit within the maintenance shop organization. Two methods of operation, which can be adapted to any maintenance shop, were described for you. You learned where to set up special tools and equipment for maximum use within the maintenance area.

Answers to Study Unit #4 Exercises

Work Unit 4-1.

1. Maintenance is the action taken to retain material in, or restore material to, a serviceable condition.
2. a. Organizational
   b. Intermediate
   c. Depot
3. a. Organizational, 1st and 2nd
   b. Intermediate, 3rd and 4th
   c. Depot, 5th

Work Unit 4-2.

1. To maintain engineer equipment or restore it or a serviceable condition.
2. supervisory
3. b. Equipment officer
4. A good all-round mechanic

Work Unit 4-3.

1. e.
2. d.
3. a.
4. b.
5. c.

Work Unit 4-4.

1. a. Job method
   b. Production line method
2. SASSY Unit.

Work Unit 4-5.

1. a. Temporary
   b. Permanent
2. A grease pit.

Work Unit 4-6.

1. At or near the workbenches in the main work area.
2. b. So glare and injurious rays will not affect others
3. They don't collect as much water.
4. d. Wear protective clothing

Work Unit 4-7.

1. Geographical location.
2. By the use of ventilation fans with roof openings.

STUDY UNIT 5

SUPPORT FUNCTIONS

STUDY UNIT OBJECTIVE: UPON SUCCESSFUL COMPLETION OF THIS STUDY UNIT, YOU WILL BE ABLE TO LIST THE PERSON(S) RESPONSIBLE FOR DIFFERENT FUNCTIONS OF ENGINEER EQUIPMENT OPERATIONS. YOU WILL BE ABLE TO LIST FOUR CATEGORIES OF PUBLICATIONS USED FOR ENGINEER MAINTENANCE. YOU WILL BE ABLE TO LIST THREE BASIC OPERATIONS THAT MAKE UP THE SUPPLY CYCLE.

Section I. ENGINEER SUPPORT

Work Unit 5-1. RESPONSIBILITIES

LIST THE PERSON(S) RESPONSIBLE FOR THE ADMINISTRATION AND CONTROL OF SUPPLIES AND EQUIPMENT IN AN ENGINEER SHOP.

NAME THE PERSON RESPONSIBLE FOR THE PROPER USE OF AN ITEM OF ENGINEER EQUIPMENT.

NAME THE PERSON RESPONSIBLE FOR PERFORMING THE ECHELONS OF MAINTENANCE ASSIGNED TO AN ORGANIZATION.

Administration and control. All personnel from the Commandant to the newest recruit are responsible for the proper use and maintenance of supplies and equipment. Although the administration and control are the responsibility of your seniors, you are responsible to them. The equipment or maintenance officer is the unit commander's technical representative. He provides technical guidance for the commander and controls the personnel in his unit. He is responsible to the commander for actions of the personnel he controls. You are the technical representative of your maintenance officer or equipment officer. You are responsible to him for your actions and for giving him as much technical assistance as possible. You are responsible for the proper use and maintenance of the publications and forms and for preparing all assignments to the best of your ability. You will provide assistance and supervision to insure success of the mission. The information from these reports and records will be used to plan, schedule, control, and supervise equipment operation and maintenance. This information will be compiled and passed on so that the budget can be computed and supplies can be obtained. Directives and other publications are used to guide administrative and control responsibilities.

Operational. The operator is assigned an item of equipment and is responsible for its proper use. He knows its capabilities and limitations and should strive to improve operating techniques so that maximum efficiency can be obtained without misuse or abuse. He knows the number of hours that the equipment has been operated and is responsible for performing his first echelon maintenance and recording the information required on the proper forms. He is the one that usually detects malfunctions. The operator is responsible for reporting malfunctions to the dispatcher and the equipment chief and recording them on the proper forms. When properly completed, the forms used by the operator are turned in to the dispatcher to be used to complete administrative records.

Maintenance. The equipment mechanic is responsible for performing the echelons of maintenance assigned to his organization. He will assist the operator, when needed, with first echelon maintenance. He is responsible for reporting misuse, abuse, or lack of maintenance to equipment and supplies. He is responsible for reporting and recording the supplies used to maintain or repair an item of equipment. Publications are provided to guide him in the maintenance and repair of equipment and the recording of required information.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. Name the person(s) responsible for the administration and control of supplies and equipment in an engineer shop.________________________________

2. Name the person responsible for the proper use of an item of engineer equipment.
____

3. Who is responsible for performing the echelons of maintenance assigned to an organization?____

Work Unit 5-2. PUBLICATIONS

LIST THE FOUR CATEGORIES OF PUBLICATIONS USED FOR ENGINEER MAINTENANCE.

There are many pages of printed matter, both commercial and military, to assist and guide you. Some are law and some are to be used as a guide only. Publications fall into different categories and may be located in different sections of your organization. They include books, manuals, manual or letter-type directives, technical reports, and other such items.

Marine Corps Order P5600.31_, Marine Corps Publications and Printing Regulations governs the printing and control of Marine Corps publications. SECNAVINST (Secretary of the Navy Instructions) 5210.11_, is the Navy-Marine Corps Standard Subject Classification System for documents. These are numerical classification codes such as: 3000 series, Operation and Readiness; 4000 series, Logistics; 5000 series, General Administrative and Management; 7000 series, Financial Management; and the 10000 series, General Material. They pertain to the subjects with which the supply and maintenance personnel are mostly concerned. The publications which pertain to the mechanic are usually located in the maintenance office. However, some units may use the company office or the supply section as the technical library. The use of an up-to-date publication that has all the latest changes is just as important as using the correct publication or vehicle part. Check the publication date, changes and their dates, and the letter of promulgation. These items will indicate the accuracy of the publication and its purpose. Publication changes should be recorded on the page provided near the front of the manual.

Marine Corps Supply Manual (MCO P4400.19). This is a 5-volume publication that outlines the responsibilities of supply and maintenance personnel. It contains general instructions that govern the allocation of funds for procuring new equipment and supplies. This publication is one source of information that will assist you in keeping records, turning in excess spares or equipment, and turning in recoverable items. The complete set (all volumes) is usually maintained in the battalion supply office.

Marine Corps orders (MCO's). These directives are printed in manual or letter-type form. They are of a continuing nature and contain the specific information needed to carry out some particular instructions. They are reviewed periodically to reduce the possibility of conflicting instructions and to insure that they are applicable and appropriate. A listing of effective Marine Corps orders is distributed quarterly so that using units can inventory their directives. They are usually filed in the company office under the numerical subject classification system.

Marine Corps bulletins (MCB's). These letters are printed in letter-type form and have the same force as a Marine Corps order. They are primarily informative or temporary in authority. Bulletins will include a self-cancellation date. Instructions contained in a bulletin should be followed carefully because they may be cancelled before they have been completely carried out. For example, if you received a bulletin that instructs you to turn in all excess tools during the month of June, do so at that time or you will not have a reference for your action and supply can refuse to accept the excess tools. Bulletins are usually filed in the same location and under the same system as Marine Corps orders.

Technical publications. Technical manuals, stock lists publications, T/O's, T/E's, TAM's, and special orders are only a few of the technical publications that are not listed under the Marine Corps directive system. Information concerning the Marine Corps technical publications system is found in Marine Corps order (MCO) 5215.14 series. A listing of authorized supply and maintenance technical publications is the stock list (SL) -1-2. Technical publications are to be maintained in a central location that will best serve all technicians, usually the equipment office and/or supply section. From these publications you can find the answers to your operation, maintenance, and supply questions.

> Technical manual (TM). A technical manual contains information, instructions, and procedures of a permanent nature pertaining to the operation, maintenance, and handling of equipment. Some manuals pertain to equipment or equipment components in general, while others pertain to a specific item of equipment or a components. General TM's pertain to a group or a class of equipment or equipment components and are general in scope and coverage. They cover subjects such as Detroit diesel engines rather than a specific item such as Detroit diesel engine 3-71 series. They are identified by a number that consists of three elements: the first element is the designator, technical manual (TM); the second element is the group or class number, a 4-digit Federal Classification number; and the third element is a point number, indicating the sequence of the manual published under that subject. The third element may also contain numbers which indicate the echelon to which it applies.

For example, TM-4700-15/1 Tactical Equipment Records Procedures has the basic 3-element numbers under the subject classification system. The first element (TM) is the publication designator for the technical manual, the second element is the subject classification number (4700) pertaining to tactical equipment records. The third element (15) indicates that the publication applies to all echelons, first through fifth. The /1 indicates that this is the first publication. Other general publications such as technical instructions (TI's) are numbered in the same manner, but contain additional numerals followed by a /, prior to the sequence number in the third element. These manuals refer to the echelons to which the instructions within the publication apply. For example, TI-6115-15/1 is the technical instruction (TI) for engine generators. The 6115 is the Federal supply classification number for engine generators; 61 is the Federal group, and 15 is the class. It is first through fifth echelon, and it is the first publication under this subject number (15/1). Department of the Army publications used by the Marine Corps do not follow this numbering system.

Specific. Publications pertaining to individual items of equipment or specific components use three element numbers. The first element is the designator and the second element is a 5-digit basic publication ID (item designator) number which has been assigned to that item. The third element is a 2-digit number which indicates the echelon of maintenance to which the information applies. For example, TM-7542A-12 is a technical manual for the Case MC 1150 Scooploader and covers information pertaining to echelons, first through second. This is listed in the TAM by TAM number B-2463 and ID number 7542A. The letter A in the second element 7542A indicates that the TM pertains to the Case MC 1150 Scooploader procured under that contract.

Lubrication instructions (LI's). Specific information pertaining to the servicing, lubrication, and related preventive maintenance procedures for a specific item of equipment are covered in the LI, often called the lube order (LO). The LI will have a drawing of the item showing the location of the check point and the time interval. It will show the types and quantities of lubricants for the different points. On some lubrication instructions the number of fittings used to lubricate a specific component is also shown. The lubrication instruction and the lubrication chart in the TM are almost identical, but the LI will most likely contain the latest changes.

Modification instructions (MI's). Instructions which authorize or direct modifications of equipment and furnish the technical instructions on how to make them are contained in MI's. The MI is usually the type instruction and authorization received after submitting an Unsatisfactory Equipment Report. They are numbered by either the general or specific numbering system; the same as described for TM's. An MI will include the following information:

Modification to be made.

How to make the change.

Materials required and those to be discarded.

MOS required to perform the modification.

Time required to complete the modification.

Where the change will be recorded.

The engineer equipment mechanic is responsible for making those modifications within his echelon. He will review the MI file prior to servicing or performing scheduled maintenance or repair to insure that the changes and modifications are included.

Technical instructions (TI). Technical advice or information pertaining to equipment will be furnished from time to time in technical instructions. A TI may be numbered by the subject classification code, the Federal group classification, or the specific item designator. (See above for examples.) Some TI's will contain instructions for making minor modifications.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. List the four categories of publications used for engineer maintenance.

a. ______________________ c. ______________________
b. ______________________ d. ______________________

2. Under which category do TM's fall? ______________________

3. Instructions which authorize modifications of equipment and furnish the technical instructions on how to make them are contained in ______________________.

Work Unit 5-3. RECORDS, FORMS, AND REPORTS

STATE WHERE ENGINEER RECORDS, FORMS, AND REPORTS SHOULD BE LOCATED.

Administrative. Engineer equipment records and forms are maintained by the administrative unit. This unit consists of the equipment officer, equipment chief, dispatcher, and clerical personnel. The records are used to plan, control, and dispatch equipment; schedule maintenance; and record equipment age, fuel consumption, and mileage. These records and forms fall into the category of adminstration and control. Some of the information required for the administration and control unit is obtained from the operational and maintenance records (records completed by the operator and the mechanic). The records, forms, and reports found in TM 4700-15/1 are maintained by the equipment section in accordance with instructions contained in Marine Corps orders and publications. If more coverage is desired, it can be found in the MCI course 13.42 Engineer Forms and Records.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. State where engineer records, forms, and reports should be located.

____

2. These records and forms cannot be used to schedule maintenance.

a. True b. False

Work Unit 5-4. INVENTORIES AND INSPECTIONS

STATE HOW OFTEN INVENTORIES SHOULD BE CONDUCTED.

DEFINE THE PURPOSE OF AN INSPECTION.

Since the requirements for storage areas will vary greatly between organic units, no attempt is made to associate specific requirements for a particular organization. Every organization maintains at least a limited amount of material for its own use, or possibly for issue to using units which it supports. In the FMF, mount-out stocks must be maintained in a state of readiness for deployment on short notice. At post and station activities, storage conditions are probably more stable, and more permanent storage provisions are established. The same general requirements for control, inspection, storage, and protection of supplies apply to all units. The following information applies to all units.

Inventories. A complete physical inventory of all items of supply is required at least once each fiscal year. At this time, property control records are compared with actual quantities of items on hand, and the necessary adjustments are made to account for any differences.

Inventory at the responsible level. At the responsible unit property officer level, custody cards and informal property records provide the basis for the inventory. The inventory officer may be the responsible unit property officer, the supply/property control officer, or any other officer designated by the commanding officer. After all items have been inventoried, quantity adjustments for items maintained on informal property records are processed by the responsible officer. Adjustments for items on custody record cards must be reported to the supply/property control officer.

Inventory at the supply/property control office level. At the same time the inventory is held at the responsible officer level, a complete inventory of all items on hand is conducted at the supply/property control office storeroom. This inventory is generally conducted under the control of the supply/property control officer and includes a verification of the unit prices, mathematical accuracy, and completeness of property records.

Adjusting property control records. Upon completion of the inventory at the responsible and supply/property control office levels, all reports of shortages or overages are reviewed by the supply/property control officer. Upon completion of this review, appropriate action is taken. When all adjustments have been prepared, approved, and posted, the property control records are stamped or annotated to indicate INVENTORY (date). The supply/property control officer notifies the commanding officer, in writing, that the inventory has been completed, and furnishes the results.

Inspections. The purpose of conducting inspections will vary with the type of inspection and the person desiring that the inspection be made. Inspections are generally conducted to determine and evaluate the supply and maintenance performance of a unit or organization. This may be done by either conducting planned, systematic physical inspections or reviewing and evaluating reports that are prepared internally. To be most effective, inspections should be planned, scheduled, and conducted by qualified personnel on a continuing basis. Organizational inspections are a command responsibility and will be scheduled and preplanned to cover the entire supply and maintenance area. This does not, or should not, prevent subordinate units within the organization from conducting internal, limited, or spot inspections to determine where deficiencies exist. What was satisfactory last month may not be this month. Inspections should serve two purposes: to discover and advise the unit commander of those conditions that require corrections as well as an overall estimate of the unit's performance and to correct whatever deficiencies have been discovered before they become or create major problems.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. How often should inventories be conducted?

2. Define the purpose of an inspection.

Section II. SUPPLY SUPPORT

Work Unit 5-5. MATERIAL CONTROL

DEFINE THE TERM SASSY.

LIST THE THREE BASIC OPERATIONS THAT MAKE UP THE SUPPLY CYCLE.

Purpose. The support of modern-day armies is a worldwide operation involving billions of dollars and thousands of individuals. The Marine Corps, because of its size, has always attempted to keep the number of persons directly engaged in supply operations to a minimum. To handle the increasing demands on material control, major steps have been taken to mechanize many routine supply operations, particularly in data collection and reporting. This mechanization provides a rapid means of gathering the information needed to intelligently decide what items are needed, where, when, and in what amount. The availability and condition of equipment which is used for training must be maintained in a ready condition for combat. The availability of repair parts are of direct concern to those responsible for supply support in the Marine Corps. The what, where, when, and in what amount regarding these items can only be obtained from one source, the user. Only he knows the present condition of his equipment. From this information he orders the replacement parts accordingly. It is on this basis that the supply system provides supply support. Regardless of supply support plans, supply support depends on the efficiency and accuracy of the men who perform in the supply field at the using or organic supply level. To insure that all units perform their supply responsibilities in the same manner, certain standards and procedures have been established. Taken together, they are referred to as organic property control. Effective performance of property control functions will provide the valid information required by a commander to intelligently determine his ability or capability to perform the mission of the unit. On the other hand, the improper performance of these functions may greatly affect the material or financial position of other units or organizations. It can also lead to waste, unnecessary overages, and shortages of supplies.

Supported Activities Supply System (SASSY). This system is now used by, and works directly for, the operating forces, battalions, squadrons, and separate companies of the FMF. SASSY centralizes accounting and record keeping. Manual reporting is reduced primarily to transaction reporting. The concept of SASSY revolves around the daily or periodic transaction reporting between the using unit and the SASSY Management Unit (SMU). More coverage may be obtained by enrolling in MCI course, 30.9, SASSY: Organic Procedures.

Property control in Fleet Marine Force units. The mission of the FMF requires that a high degree of readiness be maintained at all times so that any assignment can be accomplished with maximum efficiency. Unit commanders will exercise their command responsibility regarding the supply function when they strictly enforce control of items based on established allowances.

Each Marine air group, battalion, separate company, battery, and squadron, has a property account and is administered as a supply element. Material required by subordinate units, that is, company within the battalion or platoon within the company, is accounted for on property records and custody cards prepared and maintained by the supply element.

Stock records management and property control administration are usually delegated by the commanding officer to the supply officer. This officer is then required to perform the technical duties involved in the determination of requirements; requisitioning; and the receipt, storage, issue, accounting for, and disposal of material. The degree of effectiveness of any FMF unit is directly related to the efficiency of its supply performance. The performance of a unit may well rest on how well supply does its job.

The supply cycle. The functions of supply are many and varied. They may be divided into three basic operations which together make up what is known as the supply cycle: determination of requirements, procurement, and distribution. These three operations are not separate functions but are interrelated. If one of these functions is missing from the cycle, there is little justification for the other two. There is no point in determining the items you need and then procuring them if you do not know how you are going to handle them when they are received. You may have trouble distributing material to using units if you do not know how to obtain it.

Determination of requirements. Of the three supply operations, probably, the most important is the determination of requirements. It forms the basis for the entire operation of supply within the unit. Because of its importance, it is a responsibility of each unit commander to determine the requirements of his organization. Determination of requirements is best defined as the determination of the needs or demands for equipment, resources, facilities, or services, by specific quantities, for specific periods of time, at specified times. Basically it is knowing what you need to operate.

Procurement. This is the tool or method by which needed material is obtained. Procurement can best be defined as the act of requisitioning, purchasing, renting, leasing, or otherwise obtaining supplies or services. Although the term procurement is commonly used in the Marine Corps in reference to the purchase of supplies from sources outside the Marine Corps, it is not limited to that meaning when used in reference to the supply cycle. For practical purposes, the term procurement pertains to the acquisition of supplies and equipment, regardless of source.

Distribution. The final element of the supply cycle is distribution which involves the methods and means of moving supplies from where they are initially received to the user. Simply stated, it is the issue of supplies to the individual or unit for which the requirement exists. Distribution also includes the receipt, invoicing, and accounting for supplies.

EXERCISE: Answer the followng questions and check your answers against those listed at the end of this study unit.

1. What does the term SASSY stand for?______________________________

2. List the three basic operations that make up the supply cycle.

a.__________________ b.__________________ c.__________________

Work Unit 5-6. ORGANIZATION AND FUNCTIONS

STATE THE FUNCTION OF THE PROPERTY CONTROL OFFICE.

Introduction. A property control office may be known as post supply, battalion supply, or the supply office. The title itself is not as important as understanding the functions of the unit. This is the office which performs the organic property control functions for its parent activity or unit. The property control office is organized into sections to perform the supply functions required for support of the organization of which it is a part. Within FMF units (regiments, battalions, companies), the functions are kept to a minium consistent with the accounting and reporting requirements of the unit. At post or station activities, the functions may become extensive, and a more complex organization is required. The specific organizaion of a property control office is determined by the needs of each activity or unit. The organization is under the direction of the property control officer or supply officer. The office is generally organized around the function to be performed and within the personnel limitations. Other factors which can affect the organization are:

Number and size of supported units.

Size of storage area, if any, that must be maintained.

Volume of items controlled.

Sources of supply authorized.

Volume of correspondence or extent of administrative duties.

Functions. As a general rule the functions of a property control office include administration, procurement, receiving, issuing, and maintaining records. These tasks are grouped below with the applicable function. Remember that these functions may be combined or subdivided, depending upon the size of the organization.

Administrative section.

Administering and operating the property control office.

Preparing all correspondence pertaining to supply administration.

Initiating action relative to reports of investigation and special administration.

Prescribing internal security regulations to insure safeguarding of all supplies and property control records.

Performing internal inspection of supplies and examination of property control records.

Controlling transportation requests, meal tickets, and "cash on hand" available for meals and transfers.

Controlling issues and sales of Government property, and safeguarding funds derived from sales.

Keeping the commanding officer advised of the status of supplies and the operational efficiency of the organization.

Property control records maintenance section.

Maintaining the supply records.

Processing receipt and expenditure documents to reflect the transaction on the records.

Recommending substitution and/or procurement action for replenishment of stocks, and establishing obligations when requested items are not available for immediate issue.

Preparing necessary quantitative and monetary reports required by higher authority.

Reporting apparent excesses for possible disposal action.

Maintaining records of nonexpendable property in the hands of unit property officers.

Posting issues and recovery action on the appropriate custody record cards, and preparing new cards as required.

Procurement section.

Screening all procurement requests and determining the method of procurement.

Preparing requisition forms.

Preparing requests for open purchases and/or purchase orders.

Furnishing copies of documents to the fiscal officer for obligation and expenditure of funds.

Maintaining written records of bids and quotations in purchasing.

Entering into contracts or agreements involving the expenditure of Government funds upon approval of proper authority.

Controlling imprest funds purchases, if required.

Receiving section.

Preparing records and distributing inspection reports and rejection notices.

Verifying and accomplishing incoming bills of lading.

Forwarding verifying receipt documents to property records.

Initiating action on material lost or damaged in shipment.

Issuing section.

Issuing and withdrawing supplies from stock.

Disposing of material in accordance with prescribed regulations, and maintaining records of such action.

Maintaining catalogs, allowance publications, and stockage objective data.

Forwarding copies of issue documents to property records.

Not all the above tasks are performed by every control office, nor are they the only tasks that may be performed by some offices. They are fairly representative of the tasks that may be encountered at various activities. A thorough understanding of the fundamentals of organic property control will enable you to acquire and develop the additional skills required for these tasks.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. State the function of the property control office.________________________

2. Performing internal inspection of supplies is a function of which section in the property control office?

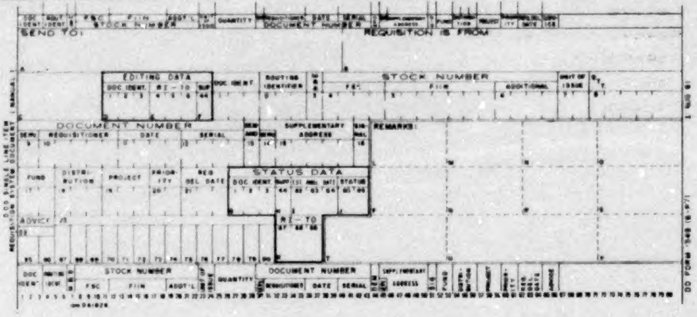
   a. Administrative section
   b. Property control records maintenance section
   c. Procurement section
   d. Receiving section

Work Unit 5-7. REQUISITIONING

STATE THE PURPOSE OF THE DD FORM 1348.

The ability of a unit or activity to accomplish its mission may well depend on the supply support it receives, and more specifically on the efficiency of its own supply function. In order to maintain its operational capability, each unit must have knowledge of three basic facts concerning its supply position: first, what kind of supplies it is authorized; second, what kind of supplies it already has; third, what kind of supplies it needs. Knowing what you are authorized and what you have is the first step in determining what you need. At this point you are principally concerned with what you do after you have determined what you need. Generally, material needs are satisfied by the submission of requisitions to your authorized supply source. Many organizations have one source and some have more than one, including commercial sources.

Normal supply channel. The large majority of supplies and repair parts will be obtained through normal supply channels. The requisition may be submitted by you, the equipment chief, or your designated representative, normally a parts clerk. Normally, the requisition is submitted on a DD Form 1348 (fig 5-1) which requires certain minimum information to be filled in the appropriate blocks as shown in the legend.


SEND TO:
REQUISITION IS FROM
EDITING DATA
STOCK NUMBER
DOCUMENT NUMBER
REMARKS:
STATUS DATA
ADVICE
RI - TO

LEGEND

1. Block A. Enter battalion supply office.
2. Block B. Enter the applicable section of the requisitioner, for example--heavy equipment section or motor transport section.
3. Block 4-5. Enter the NSN.
4. Block 7. Enter the unit of issue.
5. Block 8. Enter the quantity desired or needed.
6. Block 11. Enter Julian date.
7. Block 12. Enter the locally assigned serial number. Serial numbers will be assigned sequentially and will not be duplicated on the same day. Serial numbers will be assigned by fiscal year, beginning with 0001 through 9999 or in block sequence. If volume warrants, start with 0001 each day, week, month, or quarter, as appropriate.
8. Block 20. Enter priority of request.
9. Block L-O. Enter brief nomenclature of item requested.

Fig 5-1. DD Form 1348.

BEST COPY AVAILABLE

Pending requisition file. After you or your parts clerk have submitted your requisition for the required supplies or repair parts, you should establish a pending requisition file. This is simply your file copy of the requisition with your locally assigned serial number. Within a few days after submission of your requisition, the supply officer will give you a copy of the requisition which they submitted to their supply source. If you have not received this copy within a normal time frame, you should check with the supply office to see if the material has been ordered and to make sure your requisition has not been lost. Now that you have a copy of the requisition which was submitted by the supply office, you can throw your copy of the requisition away. You should now establish a second pending requisition file which consists of file copies of requisitions submitted by the supply office. You now have two pending requisition files; one which contains copies of your requisitions which have not been ordered by the supply office, and a second file which contains copies of requisitions which have been ordered.

Backorder validation. After you have submitted your requisition to the supply source and have received your file copy of their requisition, you cannot afford to just sit back and forget things until the material is received. Current supply orders require the supply officer to conduct a backorder validation with your records four times a year. This is simply a procedure used by the supply office personnel and yourself to make sure that all information in your pending requisition file agrees with theirs. Most supply officers set up procedures to accomplish this backorder validation more frequently, such as once each month, in order to reconcile errors or discrepancies on a more timely basis. If the supply officer has not estab- lished this procedure, you should consider doing it yourself. This can be accomplished by simply taking your pending requisition files to the supply office and setting down with the supply office clerk. You should check each of your pending requisitions with the copies on file in the supply office. At that time you must check for changes in stock numbers, quantities, and other data which may have been changed or an error has been made. Also at this time the supply office personnel may be able to give you current information such as when you may be able to expect to receive the items you requested.

Requisitioning from self-service centers.

Introduction. In the Marine Corps supply system, there are certain items which are low-cost, fast-moving, expendable supplies. These items are very suitable for issue to organizations on a pickup or self-service basis. This method eliminates the normal delay for requisition processing and pulling and marking of material for delivery or pickup by the requisitioner. This type of operation within the Marine Corps is referred to as a self-service center. The same type of operation is conducted by the General Services Administration and by other military services. Those self-service centers have four basic objectives:

Improvement of supply support to using units by providing a single distribution point for specified items.

Simplification of supply and accounting procedures by using the self-service center as the single requisitioning agency rather than submitting individual requisitions to the stock account.

Improvement of supply practices at the unit level by discouraging the ordering of excessive quantities through the assurance to using units that supplies distributed through self-service centers are available at all times on a self-service basis.

Increasing the cost consciousness of consumers through the use of monetary controls. The self-service centers are primarily responsible for providing supply support to organizations geographically located so that an authorized representative may conveniently visit the self-service center and obtain the desired supplies.

Self-service center customers. When the supported organization is located on the same base as the self-service center, or within a reasonable distance from the base, an authorized representative of the supported unit will purchase in person from the self-service center. In order that representatives of supported organizations may identify themselves as authorized customers, credit plates are issued by the self-service center. Commanding officers, as customers, are responsible for the type and quantity of items selected by customer representatives. The self-service center has no responsibility for verifying or checking the allowances of items selected by the customer representatives.

Issues from self-service centers. Only authorized customers, those who have an authentic credit plate, are permitted to purchase supplies from self-service centers. The customer must show his credit card as his identification before entering the self-service center. He then selects the desired items from shelves or bins on a self-service basis. At the checkout counter, the cashier lists the selected items on a cash register. After all items have been listed, the cashier totals the sale, imprints the customer's credit plate on the sales tape, and asks the customer to sign the original copy of the tape. A triplicate copy of the tape is given to the customer. The customer representative is required to sign a receipt for serialized items.

A catalog lists all items available from the self-service center and other information regarding the operation of the center. This catalog is published by the activity which operates the self-service center and is distributed to all activities authorized to purchase from it. The catalog, which is the basis for all issues, contains the stock number, item name and description, unit of issue, and unit price.

EXERCISE: Answer the following questions and check your answers against those listed at the end of this study unit.

1. State the purpose of the DD Form 1348.____________________________________

2. After a requisition is filled out, which file does it go into?

____

SUMMARY REVIEW

In the preceding work units you have learned the persons responsible for: the administration and control of supplies and equipment, the proper use of an item of equipment, and performing the echelons of maintenance assigned to an organization. You also learned the four categories of publication used for engineer maintenance. You learned where engineer records, forms, and reports should be located in the maintenance shop. You also learned how often inventories should be conducted, and the purpose of inspections. You learned what the term SASSY means and which three basic operations make up the supply cycle. Finally, the organization and function of the property control office, and the use of DD Form 1348 were described for you.

Answers to Study Unit #5 Exercises

Work Unit 5-1.

1. The maintenance officer
2. The operator
3. The unit mechanic

Work Unit 5-2.

1. a. Marine Corps Supply Manual
   b. Marine Corps Orders
   c. Marine Corps Bulletins
   d. Technical publications
2. Technical Publications
3. Modification Instructions

Work Unit 5-3.

1. In the administrative unit
2. FALSE

Work Unit 5-4.

1. Once each fiscal year
2. To evaluate the supply and maintenance performance of a unit or organization

Work Unit 5-5.

1. Supported Activities Supply System
2. a. Determination of requirements
   b. Procurement
   c. Distribution

Work Unit 5-6.

1. To perform the organic property control functions for its parent activity or unit
2. a. Administrative section

Work Unit 5-7.

1. To requisition spare parts and supplies
2. Pending requisition file

ENGINEER EQUIPMENT CHIEF

Review Lesson

INSTRUCTIONS: This review lesson is designed to aid you in preparing for your final exam. You should try to complete this lesson without the aid of reference materials, but if you do not know an answer, look it up and remember what it is. The enclosed answer sheet must be filled out according to the instructions on its reverse side and mailed to MCI using the envelope provided. The questions you miss will be listed with references on a feedback sheet (MCI-R69) which will be mailed to your commanding officer with your final exam. You should study the reference material for the questions you missed before taking the final exam.

A. Multiple Choice: Select the ONE answer which BEST completes the statement or answers the question. After the corresponding number on the answer sheet, blacken the appropriate circle.

Value: 1 point each

1. During which phase of an amphibious operation should you plan for the amounts of construction materials, equipment, and troops needed for an engineer task?

a. Scheduling phase
b. Reconnaissance phase
c. Planning phase
d. Execution phase

2. Which types of weather are best suited for construction and earthmoving operations?

a. Cold weather
b. Very rainy weather
c. Hot, dry weather
d. Warm, light rainy weather

3. Which characteristics influence the type of equipment and construction procedures to be used at a construction site?

a. Topographic characteristics
b. Weather characteristics
c. Leadership characteristics
d. Equipment characteristics

4. The local resources that can be used at a construction site include labor, materials, and ______________________________.

a. known saboteurs
b. equipment
c. unservicable equipment
d. medical personnel

5. Which is the most desirable form of work assignment?

a. Five paragraph order
b. Job assignment
c. Logistics assignment
d. Unit task assignment

6. Four types of information in an engineer reconnaissance are routes, defensive positions, storage areas and

a. types of equipment the enemy is using.
b. number and location of hospitals.
c. natural materials resources.
d. types of local labor available.

7. The three types of personnel that can be used to accomplish an engineer operation are troop labor, local civilians and

a. wounded personnel.
b. prisoners-of-war.
c. American civilians.
d. children.

8. You are supervising a project that requires 50 acres of land to be cleared. You have estimated that your dozers have a capability of work output of 0.25 acre per hour. How many machine hours will be required to complete this assignment? The formula $M=\frac{a}{b}$

Where: M = machine hours a = area to be cleared b = dozer output per hour.

a. 150 hours
b. 175 hours
c. 200 hours
d. 225 hours

9. You have in your work force four dozers working two shifts of 10 hours each. Using 220 machine hours, how many days will it take to complete the task? The formula: $D = \frac{M}{a \times b \times c}$ Where: D = days M = Machine hours a = dozers b = hours of work c = shifts.

   a. 2.50 days
   b. 2.75 days
   c. 3.00 days
   d. 3.25 days

10. What is the purpose of the equipment requirement schedule?

    a. To show daily deadline.
    b. To show parts requirements.
    c. To show the amount of equipment needed for daily requirements.
    d. To show the number of troops required daily.

11. What is the purpose of the equipment assignment schedule?

    a. To show equipment usage during a construction project
    b. To allow subordinate units to plan their equipment usage more efficiently
    c. To show equipment deadline figures during a construction project
    d. To show the number of troops required to complete the project

12. The two schedules which make up the construction operations schedule are the work esti- mate schedule and the

    a. equipment schedule.
    b. work assignment schedule.
    c. equipment assignment schedule.
    d. deadlined equipment schedule.

13. Three simplified methods of reporting production progress are the daily report, the accumulative report, and the

    a. monthly report.
    b. equipment report.
    c. morning report.
    d. fragmentary report.

B. Matching: In the group of items below (14-18) match the supervision factor in column 1, with its description in column 2. For each item, select the ONE letter (a, b, c, d, or e) indicating your choice. After the corresponding number on the answer sheet, blacken the appropriate circle.

Value: 1 point each

Column 1

Supervision factor

14. Defense and security of job
15. Morale
16. Health
17. Training
18. Working conditions

Column 2

Description

a. Continuous flow of knowledge and information.
b. Weather, terrain, safety, precautions, insects and vegetation affect this factor.
c. Adequate warning and outpost systems.
d. The mood or spirit of an individual or group with respect to performance and devotion to duty.
e. Anything that affects or damages members of your crew lowers production output, which in turn affects completion schedules.

C. Multiple Choice: Select the ONE answer which BEST completes the statement or answers the question. After the corresponding number on the answer sheet, blacken the appropriate circle.

Value: 1 point each

19. Three techniques of equipment supervision are inspection, maintenance and

    a. personnel rosters.
    b. project schedules.
    c. reconnaissance reports.
    d. maintenance schedules.

20. Two techniques of job supervision are personal inspection and

    a. physical fitness training.
    b. close order drill.
    c. elimination of bottlenecks.
    d. reducing the number of troops and equipment available.

21. What is a bottleneck in relationship to an engineer project?

    a. When the project is running smoothly and no problems are visible.
    b. A factor which causes a decrease in work output.
    c. A factor that can be used as a training device after successful completion of a project.
    d. A factor that can increase work output.

22. What is the purpose of an inspection?

    a. To harass the operators into doing proper maintenance
    b. To allow commanders at all echelons to determine the serviceability of their equipment
    c. To allow unit mechanics something to do during slack periods

23. How often should an equipment inspection be held?

    a. Often enough to demonstrate to the troops that emphasis is placed on preventive maintenance.
    b. Once every two to six weeks so that troops will always keep their equipment in good working order.
    c. Once a quarter if time can be made available.
    d. Once a year during slack periods of operation

24. The three types of engineer equipment inspections are command inspections, continuous spot check inspections, and

    a. Inspector General inspections.
    b. Commanding General inspections.
    c. quarterly inspections.
    d. technical inspections.

25. What is the primary use of a crawler-tractor?

    a. Grade roads and airfields
    b. Dig trenches
    c. Short haul excavations
    d. Compacting fills

26. Which types of operations are best suited for wheeled tractors?

    a. Short haul excavations
    b. Compacting fills
    c. Hauls long enough to develop high average haul and return speed
    d. Pushing rock in quarry

27. When are scrapers most efficient?

    a. When operating in light and medium soils relatively free of roots, stumps and boulders
    b. When operating in heavy compacted soils full of stumps and boulders
    c. When grading roads and airfields
    d. When loading fine, dry sand

28. What is the basic purpose of crane-shovels?

    a. Driving piles for bridge construction
    b. Lifting a load and placing it in a new position
    c. Grading roads and airfields by the use of the backshoe
    d. As push vehicle for scrapers

29. Which type of operation is best suited for road graders?

a. Working in areas with wet, heavy soil
b. Making sidehill cuts and fills
c. Pushing rocks onto dump trucks
d. Maintaining roads and airfields and general construction

30. Calculate, by the use of the formula given, the compacted volume of dry sand an MRS-105 SM-71 scraper can haul per cycle when fully loaded.

a x b = c
a = size of load
b = conversion factor
c = compacted volume in cubic yards

Select the correct answer from below.

a. 19.1 cu. yd.
b. 17.2 cu. yd.
c. 14.2 cu. yd.
d. 12.9 cu. yd.

31. Calculate, by the use of the formula given, the weight of a load of dry sand that an MRS-105 SM-71 scraper can haul when fully loaded.

a x e = f
a = size of load
e = weight in pounds of one cubic yard
f = weight of load in pounds

Select the correct answer from below.

a. 42,600 lb
b. 51,120 lb
c. 56,800 lb
d. 58,600 lb

32. Using the given formula, calculate the total time per cycle of an MRS-I-100 with an MRS-105 SM-71 scraper hauling 10,000 ft to a fill using 3d gear at 8.8 mph. The MRS-I-100 returns by a different route, traveling 12,000 ft at a speed of 12.4 mph in 4th gear.

Formula: $F + V_1 + V_2 = T$
F = Fixed time in min.
V_1 = Variable time to fill area in min.
V_2 = Variable time for return trip in min.
T = Total time per cycle

Note: See fig 2-14 in Study Unit 2 of text for needed information.

Select the correct answer.

a. 22.7 min
b. 25.8 min
c. 28.1 min
d. 29.2 min

33. Calculate, by the use of the formula given, the rolling resistance for an MRS-I-100 tractor/scraper traveling over a rutted dirt roadway (1" or more time penetration). The weight of the soil in the scraper is 56,800 lbs. The weight of the tractor is 34,710 lbs. The weight of the scraper is 28,850 lbs.

$$R = \frac{Wr}{D}$$

R = total rolling resistance (DBPP)
W = total weight
D = drawbar pull in lb/ton (2,000)
r = resistance factor

Select the correct answer from below.

a. 4,209 DBPP
b. 5,902 DBPP
c. 9,027 DBPP
d. 10,121 DBPP

34. Calculate, by the use of the formula given, the grade resistance of a tractor/scraper weighing 120, 360 lb, required to climb a 3% adverse slope.

$$P = \frac{W \times b \times g}{D}$$

P = pounds pull required
W = gross weight
D = short ton (2,000 lb)
b = lb of DBP (20)
g = grade percent

Select the correct answer from below.

a. 1,361 DBP
b. 2,361 DBP
c. 3,116 DBP
d. 3,611 DBP

35. Calculate, by the use of the formula given, the available DBPP for a Case MC 1150 scooploader operating at an altitude of 8,000 ft., for intermediate range.

Formula:
$a - b = c$
$\frac{c}{d} \times e = f$
$g - f = h$
$h \times i = j$

Where:
a = working elevation
b = elevation below which altitude has a negligible effect (3,000ft)
c = elevation efficiency effects on engine
d = 1,000ft elevation (constant)
e = 3% decrease in power (DBPP) per 1,000 ft of elevation
f = total % decrease in power
g = 100% (constant)
h = total % power available
i = total DBPP (fig 2-2)
j = available DBPP

Select the correct answer from below.

a. 27,157.5 DBPP
b. 28,157.1 DBPP
c. 52,817.1 DBPP
d. 75,281.3 DBPP

36. Calculate, using the information given, the useable pounds drawbar pull for an MRS-I-100 rubber-tired tractor, without scraper, on a loose gravel road.

weight of tractor = 34,710 lbs
weight distributions = 44%
weight on drive wheels = weight of tractor x weight distribution
maximum coefficient of friction = .36
useable lb pull = weight on drive wheels x maximum coefficient of friction = DBPP

Select the correct answer from below.

a. 4589 DBPP
b. 5498 DBPP
c. 8549 DBPP
d. 9854 DBPP

37. What is the operational efficiency of crawler-tractors during daylight?

a. 67% with the tractor working 45 min/hr
b. 76% with the tractor working 48 min/hr
c. 83% with the tractor working 50 min/hr
d. 90% with the tractor working 55 min/hr

38. What is the operational efficiency of wheeled tractors at night?

a. 58% with tractor working 35 min/hr
b. 60% with tractor working 40 min/hr
c. 65% with tractor working 40 min/hr
d. 67% with tractor working 40 min/hr

39. What is the purpose of a clearing operation?

a. Removing objectional topsoils and sod
b. Removing trees, downed timber, rubbish, and material embedded in the ground
c. Trimming trees so there are no hanging branches
d. Uprooting and removing roots and stumps

40. What is the purpose of a grubbing operations?

a. Removing trees and down timber.
b. Removing rubbish and material imbedded in the ground.
c. Removing objectional topsoils and sods.
d. Uprooting and removal of roots and stumps.

41. What is the purpose of a stripping operation?

a. To remove and dispose of objectional topsoils and sods.
b. To trim all low hanging branches and shrubs.
c. To uproot and remove roots and stumps
d. To remove trees and downed timber.

42. Which type of equipment is best suited for backfilling?

a. Dozers
b. Graders
c. Scrapers
d. Cranes

43. Which type of dozer is best suited for sidehill excavation?

a. Bulldozer
b. Small dozer
c. Angle dozer
d. Large dozer

44. The two commonly used methods for finishing side slopes are parallel and

a. slot.
b. diagonal.
c. backfilling.
d. blad to blade.

45. Three methods used to increase the production of dozers are blade to blade, downhill, and ______________________________ dozing.

a. grubbing
b. slot
c. clearing
d. stripping

46. Using the forumula $O = \frac{Q \times F \times 50 \times E}{C}$, calculate the production estimation of a Terex 82-30M tractor for the following problem.

A Terex 82-30M is dozing common earth (loam). Assuming that the limitations allow the machine to dig and carry material forward in intermediate and return in high reverse, what is the bank cubic yards production capacity of the dozer with a 100 ft pushing distance?

O = output per hour = ?
Q = capacity of equipment = 7.9 cu yd.
F = soil conversion factor = 1.25
50 = min per hour
E = Equipment efficiency factor = .83
C = Cycle time = .63 min

Select the correct answer from below.

a. 460.3 Banked cubic yds per hour
b. 650.5 Banked cubic yds per hour
c. 781.6 Banked cubic yds per hour
d. 871.8 Banked cubic yds per hour

47. Downhill and straddle loading are two types of loading used with a scraper. What is the third type of loading used that requires teamwork to eliminate waiting time?

a. Loading with shovels.
b. Loading with cranes.
c. Loading with a push dozer.
d. Loading with a scooploader.

48. Why should haul roads have a heavy compacted cover of good material?

a. To withstand traffic.
b. So scrapers can overhaul.
c. To save graders for other jobs.
d. So crawler-tractors can move from job to job faster.

49. Why do turns cause a loss of time in hauling operations?

a. Scrapers turn over.
b. Scrapers have to stop each time they shift gears.
c. Scrapers have to slow down, shift gears, and travel extra distances.
d. Scrapers have a tendency to slide in curves.

50. Two methods of constructing fills using a scraper are unloading and

a. straddle loading.
b. tandem dozing.
c. grubbing.
d. rough grading.

51. Using the formula $O = \frac{Q \times F \times 45 \times E}{C}$, calculate the production estimation of a tractor/scraper in the following prolem.

An MRS-I-100 tractor pulling an MRS-105 SM-71 scraper hauls loam to a fill area a distance of 2,500 feet. Traveling to the fill area in 2nd gear and returning in 3rd gear, what is the volume of material that can be moved per hour by this unit during daylight hours?

O = Output per hour
Q = 10.50
F = 1.25
45 = 45
E = .83
C = 5.52

Select the correct answer from below.

a. 80.18 cy yd per hour
b. 88.81 cu yd per hour
c. 95.06 cu yd per hour
d. 101.60 cu yd per hour

52. What is the purpose of marking ditches during cutting operations?

a. So the operator will know the width of the road being cut.
b. To get material to build up the crown of the road.
c. For better blade control and straighter ditches.

53. What depth should ditching cuts be made during cutting operations?

a. Deep enough to stall the grader.
b. Just deep enough so there is not strain on the engine.
c. As deep as the operator feels necessary to get the job done.
d. As deep as possible without stalling or losing control of grader.

54. Which grader operation forms the crown of a road?

a. Leveling windrows
b. Moving windrows
c. Making ditching cuts
d. Sloping the bank

55. Why is bank sloping necessary?

a. To allow the ditch to fill up faster.
b. To prevent excessive or immediate erosion of the bank slope.
c. To get more material for filling operations.
d. To build up the crown of the road.

56. What purpose does the crown of a road serve?

a. As a dividing line between lanes of traffic
b. To allow easier grading of the roadbed
c. To remove surface water from the roadbed
d. To pile dirt for final removal

57. What are the two methods used to maintain a surface with a road grader?

a. Slot dozing and blade-to-blade
b. Scarifying and material distribution
c. Scarifying and blade-to-blade
d. Material distribution and slot dozing

58. Estimate, by using of the formula given, the work output of a grader in the following problem.

$$\text{Total time (hrs)} = \frac{PD}{SE} + \frac{PD}{SE} + \frac{PD}{SE}$$

P = number of passes
D = distance in miles
S = speed
E = efficiency

Three miles of road are to be reshaped by a road grader. Six passes are estimated to be required to complete the job. The type of material to be worked permits passes 1 and 2 to be mae in 2d gear (2.8 mph), passes 3 and 4 in 3d gear (3.4 mph), and passes 5 and 6 in 4th gear (5.6 mph). How much time is required to complete the project? (The efficiency factor is 0.70).

Select the correct answer from below.

a. 2.18 hrs
b. 3.26 hrs
c. 5.21 hrs
d. 8.12 hrs

59. Two factors that are important in the elimination of unnecessary passes are planning and the

a. proper working speed.
b. number of graders.
c. skill of the operator.
d. type of grader being used.

60. The two types of cranes used in the Marine Corps are the truck-mounted and the

a. angle mounted.
b. overhead mounted.
c. hydraulic mounted.
d. crawler mounted.

61. Why is a shovel front the most widely used type of excavating equipment?

a. Because it can be used where controlled excavation is required.
b. Because it can dig harder materials.
c. Because of the ease with which it can be transported.

62. When is a clamshell best used?

a. When working against a high working face
b. Where controlled excavation is required, such as trenches or footings.
c. When working in solid rock
d. When excavating drainage canals

63. For which type of operation is a dragline generally used?

a. For operations such as drainage canals where extended reach is an important factor.
b. Where controlled excavation is required.
c. When working in solid rock
d. When working against a high working face

64. What is the primary use of a backhoe?

a. Excavating drainage canals
b. Working in solid rock
c. Operating where extended reach is required.
d. Digging below ground level

65. The three tests used for soil classification are sieve analysis, wet mechanical analysis, and

a. wet sieve analysis.
b. rock analysis.
c. combined mechanical analysis.
d. manual analysis.

66. Plasticity, moisture content, shrinkage, swelling, and bulking of sands are properties of soil. Which is another property of soil?

a. Saturation point
b. Sand content
c. Cohesion
d. Organic content

D. Matching: In the group of items below (67-70), match each of the four soil groups in column 1, with the appropriate characteristic in column 2. For each item, select the ONE letter (a, b, c, d, or e) indicating your choice. After the corresponding number on the answer sheet, blacken the appropriate circle.

Column 1

Soil groups

67.. Organic

68. Sand

69. Gravel

70. Fines

Column 2

Characteristics

a. Grain size large than 1/4 in.
b. Solid bedrock
c. Fibrous texture
d. Plasticity and compressibility
e. Grain size from .10mm to .2mm

E. Multiple Choice: Select the ONE answer which BEST completes the statement or answers the question. After the corresponding number on the answer sheet, blacken the appropriate circle.

Value: 1 point each

71. The three different types of surveys used on a construction site are the reconnaissance survey, preliminary survey, and the

a. personnel survey.
b. construction layout survey.
c. final survey.
d. pre-construction survey.

72. What is the primary use of construction stakes?

a. To allow the equipment chief to follow the progress of the project
b. To indicate the alinement of the project to the equipment operators and construction crews
c. To provide more work for the construction crews, making and placing the stakes

73. What methods are used to drain surface water from roads and airfields?

a. Adequate crowns or transverse slopes
b. Drainage ditches and culverts
c. Adequate crowns and drainage ditches
d. Transverse slopes and culverts

74. What type of drain is used to eliminate water in the subgrade or base courses of a road or airfield?

a. Surface drains
b. Temporary drains
c. Subsurface drains
d. Outfall ditches

75. For what reason is a ground reconnaissance desirable at a construction site?

a. To locate and destroy the enemy
b. To find the conditions that affect drainage that can only be seen by visiting the site
c. To get an idea of what local resources are available.
d. To locate defensive positions for troops

76. What is the purpose of temporary drains?

a. To drain water out of streambeds and ponds
b. To eliminate delays and future failures due to saturated subgrades during construction.
c. To allow construction crews to work together before actual construction begins on a project.
d. To collect water in a holding pond for recreational uses during construction.

77. What effect could the improper selection of a construction crew have on a construction project?

a. Deletion of on the job training
b. Expedite materials delivery
c. Delays in operations
d. Changes in traffic overlays

78. What is the purpose of a traffic circulation overlay?

a. To plan for traffic signals
b. To find an agreeable location for the dining facility
c. To allow untrained operators to be utilized
d. To eliminate bottlenecks

79. Clearing, stripping, ditching and channeling, cutting and filling, and fine grading are tasks necessary to begin a construction project. Which is another task?

a. Soil analysis
b. Compaction of soils
c. Setting up a quarry
d. Elimination of windrows

80. Organizational maintenance and intermediate maintenance are categories of maintenance. Which is the third category of maintenance?

a. Depot maintenance.
b. Base maintenance.
c. Division maintenance.
d. Fleet maintenance.

F. Matching: In the group of items below (81-83) match the category of maintenance in column 1 to the echelons of maintenance in column 2. For each item select ONE letter (a, b, c, or d) indicating your choice. After the corresponding number on the answer sheet, blacken the appropriate circle.

Value: 1 point each

Column 1

Categories of maintenance

81. Depot

82. Intermediate

83. Organizational

Column 2

Echelons of maintenance

a. First and second
b. Third and fourth
c. Fifth
d. Sixth

G. Multiple Choice: Select the ONE answer which BEST completes the statement or answers the question. After the corresponding number on the answer sheet, blacken the appropriate circle.

Value: 1 point each

84. What is the major objective in establishing a repair shop organization?

a. To provide a basis by which management can most efficiently maintain equipment in a serviceable condition.
b. So that the equipment chief can have better control of his troops.
c. To allow the equipment officer more time to oversee construction operations.
d. To give troops a better opportunity to work closer together and to be able to cross train.

H. Matching: In the group of items below (85-88), match the unit in column 1 with the responsibility in column 2. For each item select ONE letter (a, b, c, d, or e) indicating your choice. After the corresponding number on the answer sheet, blacken the appropriate circle.

Value: 1 point each

Column 1

Unit

85. Administrative

86. Inspection

87. Production control

88. Repair parts

Column 2

Responsibility

a. Establish priorities for work to be performed
b. Maintain adequate tool rooms
c. Accomplish the work listed on Equipment Repair Order
d. Insure that all modifications have been performed
e. Inspect incoming equipment record for completeness

I. Multiple Choice: Select the ONE answer which BEST completes the statement or answers the question. After the corresponding number on the answer sheet, blacken the appropriate circle.

Value: 1 point each

89. The two methods of operation in a maintenance shop are production line method and

a. piece method.
b. job method.
c. schedule method.
d. shop method.

90. The two types of maintenance areas are temporary and

a. permanent.
b. large.
c. stalls.
d. grease racks.

91. Which of the three types of servicing areas is the safest for service on the underside of engineer equipment?

a. Grease pit
b. Grease rack
c. Combination grease rack and pit
d. Grease stall

92. Where should special tools and equipment be placed in a maintenance shop?

a. In the tool room
b. In supply
c. At or near the workbenches
d. In the administration office

93. Which factor determines whether or not you heat your shop?

a. Size of the shop
b. Number of personnel
c. Amount of equipment being serviced
d. Geographical location

94. How should exhaust gases be removed from the overhead of a maintenance shop?

a. Remove panels in the roof
b. Use a smoke eater
c. Use ventilating fans with roof openings
d. Spray water in the overhead

95. Who is responsible for the administration and control of supplies and equipment in an engineer shop?

a. The unit mechanic
b. The equipment chief
c. The equipment/maintenance officer
d. The administration clerk

96. Who is responsible for the proper use of an item of engineer equipment?

a. The unit mechanic
b. The equipment operator
c. The equipment chief
d. The equipment officer

97. The person responsible for performing the echelons of maintenance assigned to an organization is the

a. unit mechanic.
b. equipment operator.
c. supply man.
d. equipment chief.

98. The four categories of publications used for engineer maintenance are the Marine Corps Supply Manual, Marine Corps Orders, Marine Corps Bulletins, and

a. JAG manual.
b. technical publications.
c. Guidebook for Marines.
d. modification instructions.

99. In which shop unit should engineer records, forms, and reports be located?

a. The tool room
b. The inspection unit
c. The repair unit
d. The administrative unit

100. How often should inventories be conducted?

a. Every three months
b. Every six months
c. Once each fiscal year
d. Every two years

101. What is the purpose of an inspection?

a. To harass operators and mechanics
b. To show a unit the authority of its leaders
c. To check quantities on hand against property control cards
d. To evaluate the supply and maintenance performance of a unit

102. What does the term SASSY stand for?

a. Supported Activities Supply System
b. Supply and Services System
c. Support and Service System
d. Supply Activity Service System

103. The three basic operations that make up the supply cycle are the determination of requirements, procurement, and

a. acceptance.
b. distribution.
c. storage.
d. filing.

104. What is the function of the property control office?

a. To care for and store excess items of engineer equipment
b. To collect funds at the dining facility
c. To perform the organic property control functions for its parent activity or unit
d. To control maintenance procedures for an activity or unit

105. What is the purpose of the DD Form 1348?

a. Maintenance checklist
b. Trip ticket for engineer equipment
c. Property control log
d. Requisition of spare parts and supplies

Total Points: 105

* * *

T&E-1

STUDENT COURSE CONTENT ASSISTANCE REQUEST

DATE:

COURSE NUMBER COURSE TITLE

NAME RANK MOS

SOCIAL SECURITY NUMBER

1. Use this form for any questions you may have about the course. Write out your question and refer to the study unit, work unit, or study question with which you are having problems. Complete the self-addressed block on the reverse side. Before mailing, fold the form and staple it so that MCI's address is showing. Additional sheets may be attached to this side of the form.

MY QUESTION IS: OUR ANSWER IS:

SIGNATURE (TITLE OR RANK)

STUDENT: Detach and retain this portion.

DATA REQUIRED BY THE PRIVACY ACT OF 1974
(5 U.S.C. 522A)

1. AUTHORITY: Title 5, USC, Sec. 301. Use of your Social Security Number is authorized by Executive Order 9397 of 22 Nov 43.

2. PRINCIPAL PURPOSE: The Student Course Content Assistance Request is used to transmit information concerning student participation in MCI courses.

3. ROUTINE USE: This information is used by MCI personnel to research student inquiries. In some cases information contained therein is used to update correspondence courses and individual student records maintained by the Marine Corps Institute.

4. MANDATORY OR VOLUNTARY DISCLOSURE AND EFFECT ON INDIVIDUAL NOT PROVIDING INFORMATION: Disclosure is voluntary. Failure to provide information may result in the provision of incomplete service to your inquiry. Failure to provide your Social Security Number will delay the processing of your assistance request.

INSTRUCTIONS TO STUDENT

1. Fold so that MCI address is outside
2. Insert course number in square marked "Course Number" below
3. Seal with scotch tape or one staple
4. Mail to MCI

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COURSE IMPROVEMENT SURVEY

The Marine Corps Institute would appreciate your help in improving the course you have just completed. If you would take a few minutes to complete the following survey, we would have valuable information to help us improve this course. Your answers will be kept confidential and will in no way affect your grade.

Course Number ☐ Rank________________ MOS____________

Name (Optional) ____________________________

Military Address (Optional) ____________________________________

1. Did you find inaccurate or outdated information in this course? ☐ Yes ☐ No

   List the areas you found inaccurate or out of date. Give page or paragraph if possible.

   ____

   ____

   ____

2. How long did it take you to finish the course?

   ☐ 1-5 hours ☐ 11-15 hours ☐ More than 20 hours
   ☐ 6-10 hours ☐ 16-20 hours

3. Were the procedures taught in this course understandable and useful? ☐ Yes ☐ No

   If "No," how could they be improved? ____________________________

   ____

4. How much of the material taught in this course can you apply to your job?

   ☐ Almost all ☐ Very little ☐ None
   ☐ More than half ☐ Less than half

5. Did you have trouble reading or understanding the material in this course? ☐ Yes ☐ No

   If "Yes,", explain____________________________________

6. Were the illustrations in this course helpful? ☐ Yes ☐ No

   If "No," how could they be improved?____________________________

7. Put an "X" in a box on the scale below to show how well you feel the lessons and the course materials prepared you for the final examination. (On this scale "10" indicates that the material prepared you very well, a "5" indicates adequate preparation, and a "1" indicates very poor preparation.)

   Very Poor Adequate Very Well

1	2	3	4	5	6	7	8	9	10

8. If you asked MCI for help, were the answers to your questions helpful?

   ☐ Yes ☐ No ☐ No questions sent to MCI

9. Please list below any suggestions you may have to improve this course. Try to be specific; give page or paragraph numbers. (You may also use the space on the back or attach additional sheets.)

INSTRUCTIONS TO STUDENT

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